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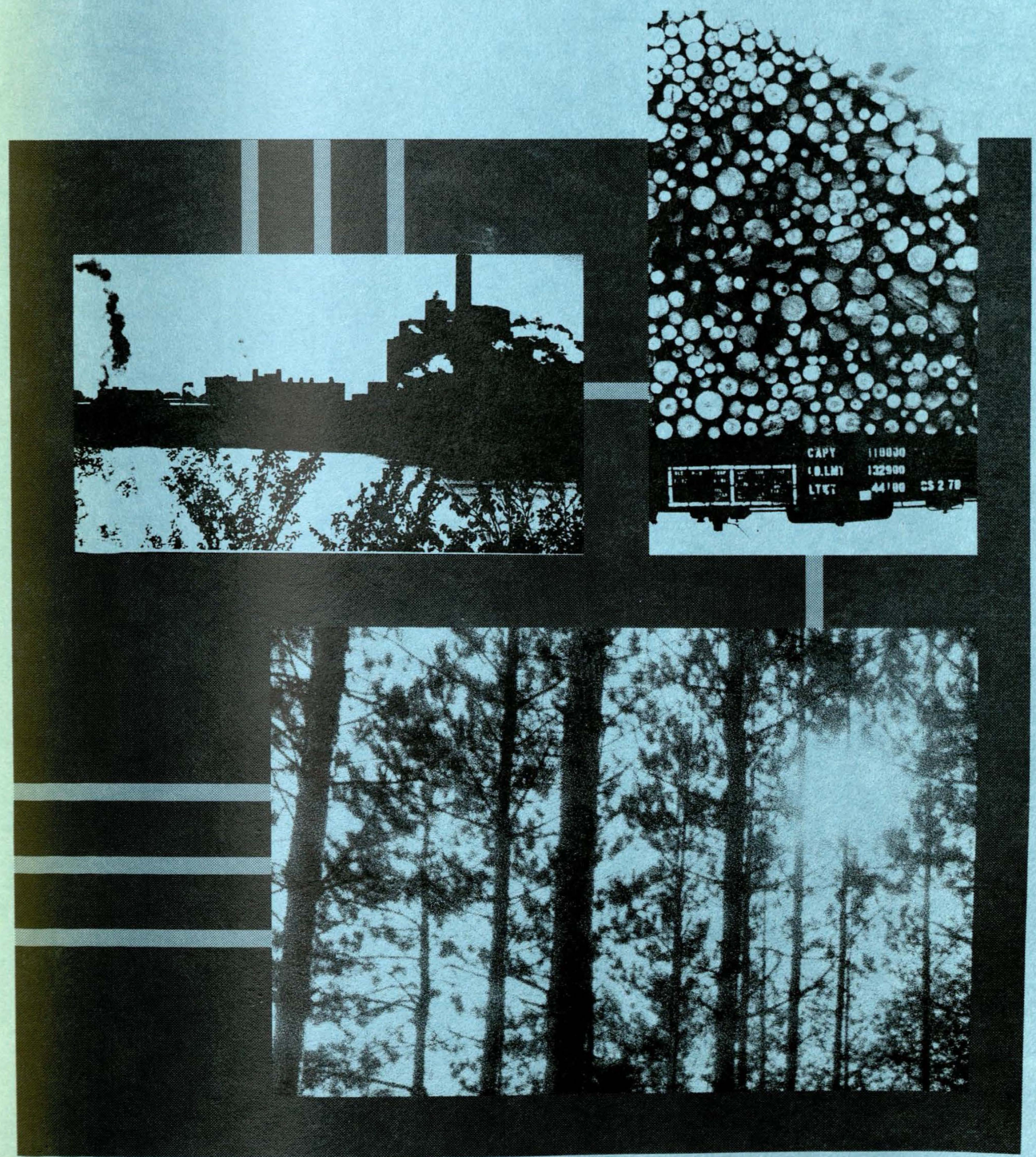
Assessing Removals for North Central Forest Inventories

W. Brad Smith



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FOREWORD

Forest Inventory and Analysis (FIA) is a continuing endeavor as mandated by the Renewable Forest and Rangeland Resources Planning Act of 1974. Prior inventories were mandated by the McSweeney-McNary Forest Research Act of 1928. The objective of FIA is to periodically inventory the Nation's forest land to determine its extent, condition, volume of timber, growth, and removals. USDA Forest Service regional experiment stations are responsible for conducting these inventories and publishing summary reports for individual States. The North Central Forest Experiment Station is responsible for forest resource evaluation in Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin.

The studies described in this report would not be possible without the time and cooperation provided by the following agencies in our region:

Illinois Department of Conservation
Indiana Department of Natural Resources
Iowa Department of Natural Resources
Kansas State University Extension Forestry
Michigan Department of Natural Resources
Minnesota Department of Natural Resources
Missouri Department of Conservation
Nebraska Department of Forestry, Fisheries, & Wildlife
North Dakota Forest Service
South Dakota Division of Forestry
Wisconsin Department of Natural Resources

We appreciate the cooperation of the many companies and individuals that have taken the time and effort to provide us with harvesting information over the years.

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Assessing Removals for North Central Forest Inventories

W. Brad Smith

INTRODUCTION

- *Is the timber industry declining or increasing in terms of total product output and consumption?*
- *Is one segment of the timber industry growing at the expense of another?*
- *Is the harvest level of a given species harming the resource or environment?*
- *Are there underutilized species and can we find markets for them?*
- *What is the current status of fuelwood production?*
- *Are species with catastrophic losses from disease, weather, and insect infestations being utilized?*
- *What are the effects of industrial expansion on the resource?*

Timely and accurate timber removals information is essential to the framing and analysis of environmentally and economically sound forest policies and programs in response to these and many other questions. This report will discuss the terminology and methods used by the Forest Inventory and Analysis (FIA) Unit to describe growing-stock and nongrowing-stock removals in the north central region (fig. 1).

The terminology used in describing removals can be confusing. An overview of basic removals terms and how they are integrated into the FIA classification scheme is shown in figure 2. Complete definitions of these terms are found in Appendix A. The two classes of trees shown at the top of figure 2 represent a simplified view of how trees are classified during a Forest Service inventory. The brackets beside each tree categorize the potential use of each section and how that section would be described if the tree were harvested or otherwise removed from the available timber base. From a forest inventory point of view, however, we rarely know how trees cut between inventories were bucked into roundwood products.

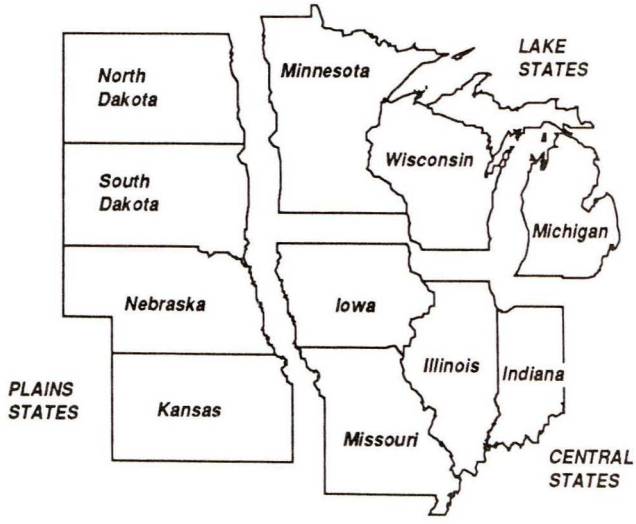

Figure 1.—*States inventoried by the North Central Forest Inventory and Analysis Unit.*

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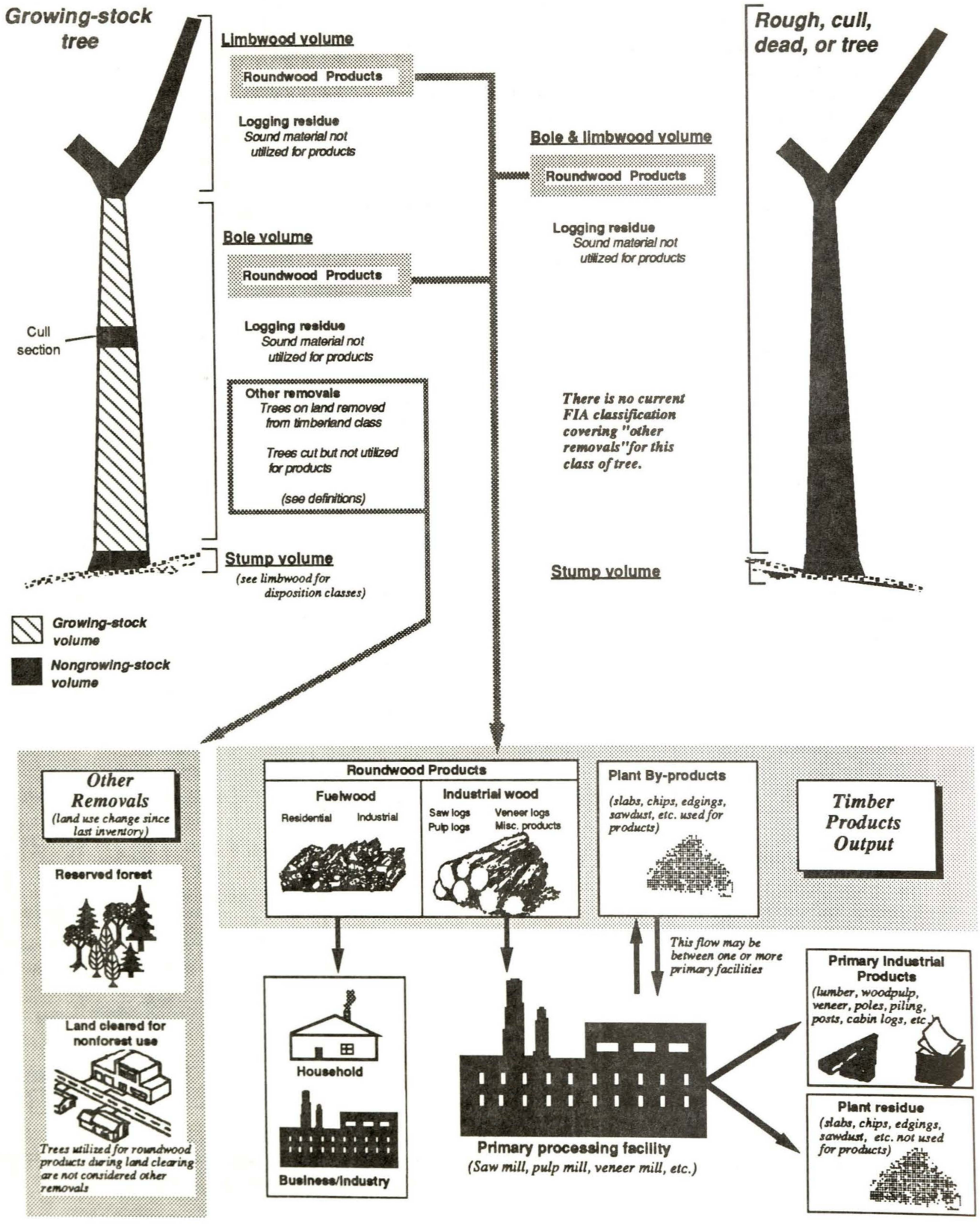


Figure 2.—*FIA removals flow by source of material and disposition.*

In addition to the terms presented in figure 2, timber removals reports frequently refer to roundwood "production" and "receipts". All tree sections bucked for roundwood products at logging sites within an analysis area are considered to be "production". However, all roundwood products cut and shipped *(exported)* to users outside the analysis area cannot be counted as receipts within the analysis area. In turn, logs and bolts harvested outside the analysis area and shipped *(imported)* by users inside the analysis area are counted as receipts, but are not considered production (timber products output) within the analysis area (fig. 3). This report will discuss these and other problems we encounter in defining the origin and disposition of roundwood products.

NOTE: *If a State or analysis region is nearly self-sufficient, then total production and receipts will be quite similar, but never synonymous. The significance of this difference is most important when the primary import and export species are different. Also, "timber products output" (production) should not be confused with "growing-stock removals." As you can see in figure 3, growing-stock removals may be either greater or less than timber products output volume depending on the amount of cull and dead material used for products and the volume of growing-stock residues generated during logging. Figure 2 also provides information useful in understanding this distinction.*

The North Central Forest Inventory and Analysis (FIA) Unit uses two methods to estimate the level of removals for each State within its territory. The first method provides and estimates average annual removals between inventories and relies entirely on remeasurement data collected during the forest inventory of each State. The second method combines data from remeasured forest inventory plots with data from primary production studies. Logging utilization studies provide the information for converting primary products data into estimates of timber removals.

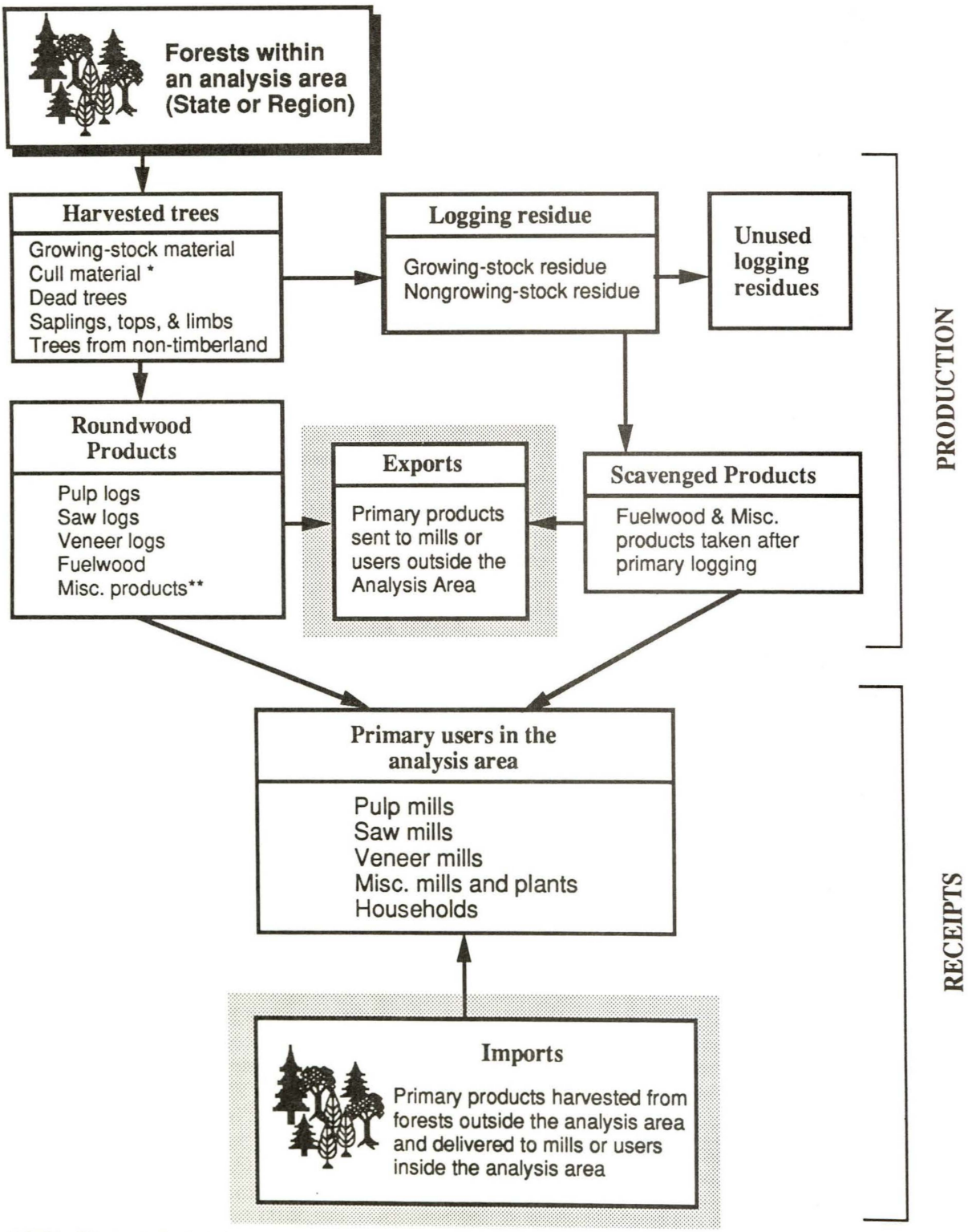
Each method describes removals in each State and provides a check-and-balance of estimates provided. The remeasured inventory method, used to estimate ***average annual removals*** between State inventories, is the standard estimate of removals provided in the Eastwide Core Tables (Hansen *et al.* 1991). The Eastwide Core Tables are 25 standard inventory tables produced by the Eastern FIA Units (North Central, Northeastern, Southeastern, and Southern Forest Experiment Stations) for each new State inventory in their respective territories. The primary production study method is used to provide the best estimate of ***current annual removals.*** Because the State forestry agency must collect much of the data, primary production studies are implemented as frequently as State's desire to update trends in removals and inventory.

This report will discuss each of these methods in detail.

ESTIMATING AVERAGE ANNUAL REMOVALS

Average annual removals estimates are based upon data collected during a remeasurement of State forest inventory plots (fig. 4). Volume is estimated for the trees cut on plots classified as timberland at the last inventory and for standing trees on plots where land use has changed from timberland to another use such as reserved forest land. An example of the latter situation would be a plot that was timberland at the last inventory and is now reserved as park land with the trees.

An important step in determining average annual removals is the assignment of the area expanders to the inventory plots that will be used as the basis of removals estimates. This process largely depends on the inventory sampling design. Two designs are currently used by North Central FIA surveys; the first is a growth model enhanced sample design and the second is a simple continuous forest inventory (CFI) design where all plots are remeasured. The growth model used in the enhanced survey design is the Stand and Tree Evaluation and Modeling System (STEMS) described by Belcher *et al.* (1982) and Shifley (1987). It is similar to sampling with partial replacement (SPR), in that a set of randomly located plots is available for remeasurement and a random set of new plots



* *Cull by FIA standards - includes cull trees, cull sections of growing-stock trees,and trees of noncommercfial species.*

** *Roundwood cut for poles, posts, piling, charcoal, etc.*

Figure 3.—*Flow of harvested trees from the forest to primary users for a specified analysis area.*

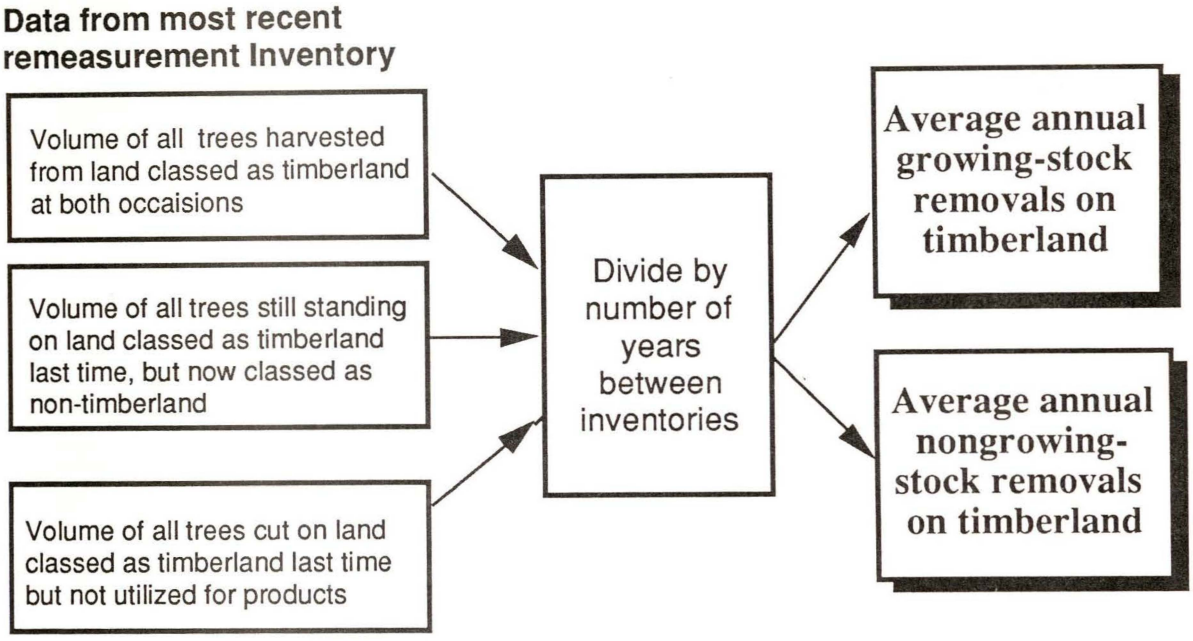

Data from most recent remeasurement Inventory
Volume of all trees harvested from land classed as timberland at both occaisions
Volume of all trees still standing on land classed as timberland last time, but now classed as non-timberland
Volume of all trees cut on land classed as timberland last time but not utilized for products
Divide by number of years between inventories
Average annual growing-stock removals on timberland
Average annual nongrowing-stock removals on timberland

Figure 4.—*Components of estimation for average annual removals.*

is established and measured. A significant feature of the new design is stratification for disturbance on the old sample and use of a growth model to improve regression estimates made on old undisturbed forest plots (fig. 5). Disturbance refers to any change on a plot that can be detected on aerial photos that STEMS cannot predict, such as catastrophic mortality, cutting, seedling stands, and land use change. A complete description of integrated STEMS inventory design is available in "*A comprehensive sampling system for forest inventory based on an individual tree growth model*" (Hansen 1990).

An estimate of ***average annual removals*** is made based on only plots that are actually visited in the field whether the STEMS enhanced design or a simple remeasurement design is used. With this in mind, allowances must be made for the redistribution of the area expanders for plots from the previous inventory that were modeled (STEMS design only), lost, or denied access at the current measurement. Figure 6 provides an overview of the process used to re-allocate acres for removals expanders.

A second important consideration in computing removals volume is the establishment of the d.b.h. of each tree at the time it was cut, or removed from the timberland inventory such as with "other removals" caused by reclassification of timberland. The problem is the same for both survey designs. There is, of course, no possibility of direct measurement in the first case because we could not be there to observe when each tree was cut. North Central FIA procedures preclude direct measurement in the second case because our crews do not currently remeasure trees on plots that have changed land use from timberland to non-timberland. We use the STEMS individual tree growth model as a surrogate for remeasuring these trees, to update all removal trees in the inventory data set to the midpoint year of the inventory cycle. The growth model is adjusted for local conditions by a modification of the method described by Smith (1983) using tree data from undisturbed remeasurement plots from the current inventory for calibration. An average volume is derived for removals and growth on removals for each tree cut or reclassified.

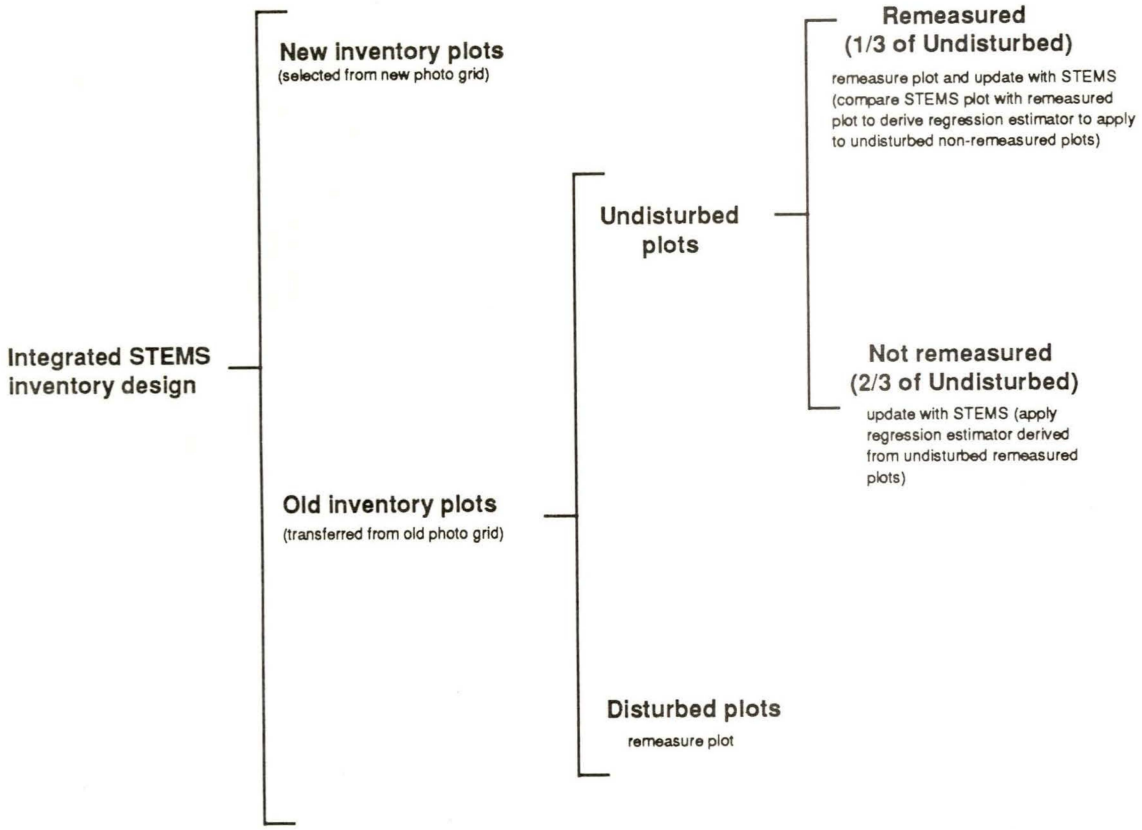

Integrated STEMS inventory design
New inventory plots
(selected from new photo grid)
Old inventory plots
(transferred from old photo grid)
Undisturbed plots
Remeasured (1/3 of Undisturbed)
remeasure plot and update with STEMS (compare STEMS plot with remeasured plot to derive regression estimator to apply to undisturbed non-remeasured plots)
Not remeasured (2/3 of Undisturbed)
update with STEMS (apply regression estimator derived from undisturbed remeasured plots)
Disturbed plots
remeasure plot

Figure 5.—Overview of the STEMS sample design.

All previous inventory plots sent to the field and located for remeasurement are inventoried according to the procedures documented in "*North Central Forest Inventory and Analysis Field Instructions*" (Ostrom and Van Cleve 1991). For remeasurement plots where trees have been cut, landowners are contacted to determine which species and diameter classes were used for products. Those species cut but not used for products are included in "other removals" and combined with the land change removals mentioned earlier for summary purposes.

Because FIA determines the owner class for each remeasurement plot, ***average annual removals*** for all products and average annual other removals may also be estimated by owner class. Owner classes include National Forest, Other federal, State, County and municipal, Forest industry, and Other private.

Because removal trees will generally comprise less than 25 percent of merchantable trees tallied during an FIA measurement inventory, the sampling error for removals will be greater than that for volume or growth. Table 1 demonstrates the size of this difference for several recently completed State inventories:

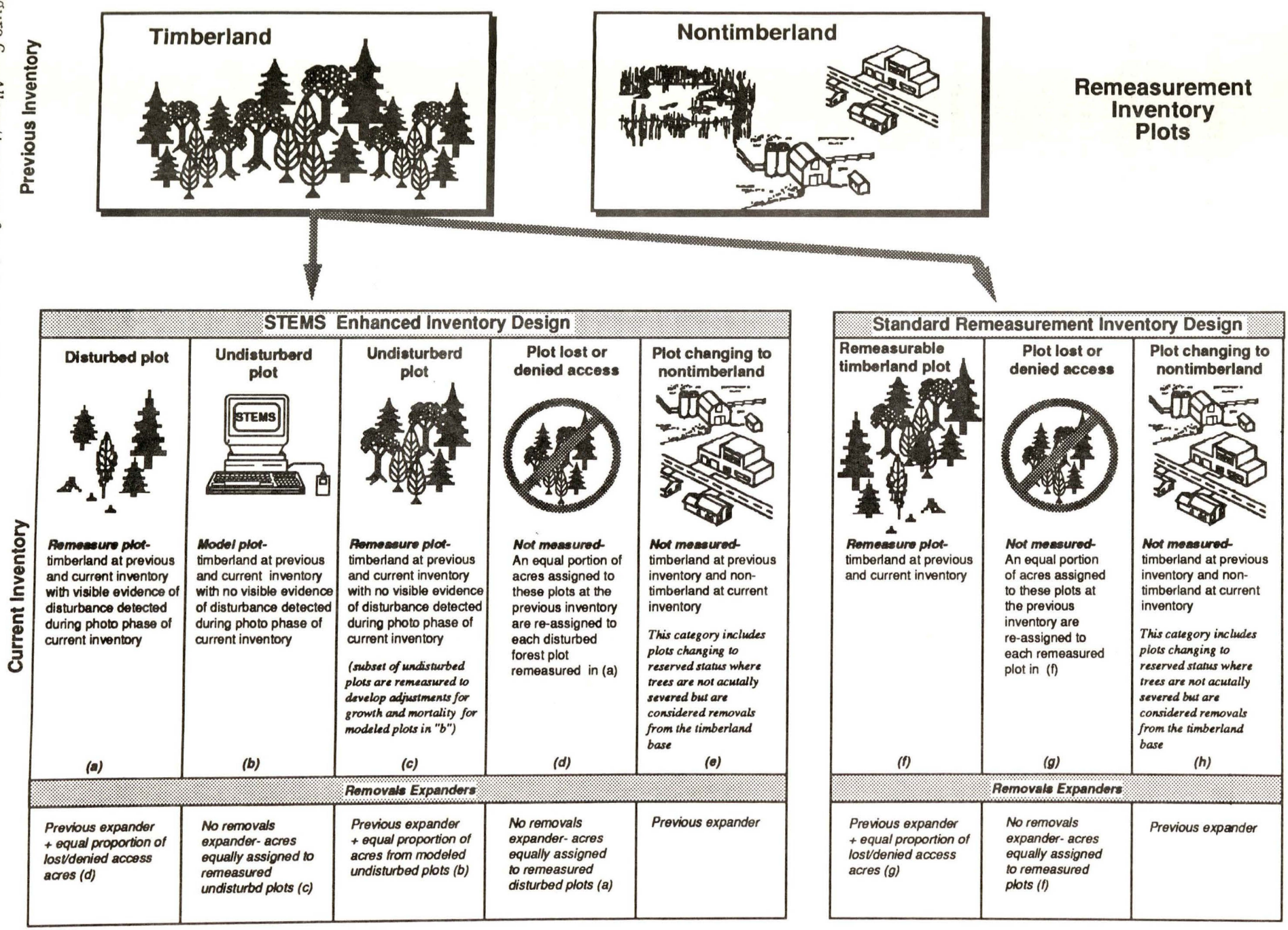

Previous Inventory
Timberland
Nontimberland
Remeasurement Inventory Plots
Current Inventory
STEMS Enhanced Inventory Design
Disturbed plot
Undisturberd plot
Undisturberd plot
Plot lost or denied access
Plot changing to nontimberland
STEMS
Remeasure plot- timberland at previous and current inventory with visible evidence of disturbance detected during photo phase of current inventory
(a)
Model plot- timberland at previous and current inventory with no visible evidence of disturbance detected during photo phase of current inventory
(b)
Remeasure plot- timberland at previous and current inventory with no visible evidence of disturbance detected during photo phase of current inventory
(subset of undisturbed plots are remeasured to develop adjustments for growth and mortality for modeled plots in "b")
(c)
Not measured- An equal portion of acres assigned to these plots at the previous inventory are re-assigned to each disturbed forest plot remeasured in (a)
(d)
Not measured- timberland at previous inventory and non-timberland at current inventory
This category includes plots changing to reserved status where trees are not acutally severed but are considered removals from the timberland base
(e)
Removals Expanders
Previous expander + equal proportion of lost/denied access acres (d)
No removals expander- acres equally assigned to remeasured undisturbd plots (c)
Previous expander + equal proportion of acres from modeled undisturbed plots (b)
No removals expander- acres equally assigned to remeasured disturbed plots (a)
Previous expander
Standard Remeasurement Inventory Design
Remeasurable timberland plot
Plot lost or denied access
Plot changing to nontimberland
Remeasure plot- timberland at previous and current inventory
(f)
Not measured- An equal portion of acres assigned to these plots at the previous inventory are re-assigned to each remeasured plot in (f)
(g)
Not measured- timberland at previous inventory and non-timberland at current inventory
This category includes plots changing to reserved status where trees are not acutally severed but are considered removals from the timberland base
(h)
Removals Expanders
Previous expander + equal proportion of lost/denied access acres (g)
No removals expander- acres equally assigned to remeasured plots (f)
Previous expander

Figure 6.—*Allocating acres for plot area expanders to estimate average annual removals.*

Table 1.— *Estimates of sampling errors on current volume, average annual growth, and average annual removals for several recent State inventories*

State	Year	Volume	Growth	Average annual removals
		----Percent sampling error----		
Illinois	1985	1.99	3.36	9.20
Indiana	1986	1.57	3.42	5.40
Missouri	1989	1.04	1.56	5.92

ESTIMATING CURRENT ANNUAL REMOVALS

North Central FIA uses a second method of estimating removals which is based upon the output of primary products delivered to primary users such as mills or households (fig. 7). Two basic types of studies are used in this effort. The first is targeted at primary industrial wood use such as pulp mills and sawmills; and the second is targeted at nonindustrial use that generally includes members of households and loggers producing residential fuelwood. Timing of these studies varies since the State forestry agency usually works with FIA in collecting primary data. Complete mill studies in each State each year would be prohibitively time-consuming and expensive.

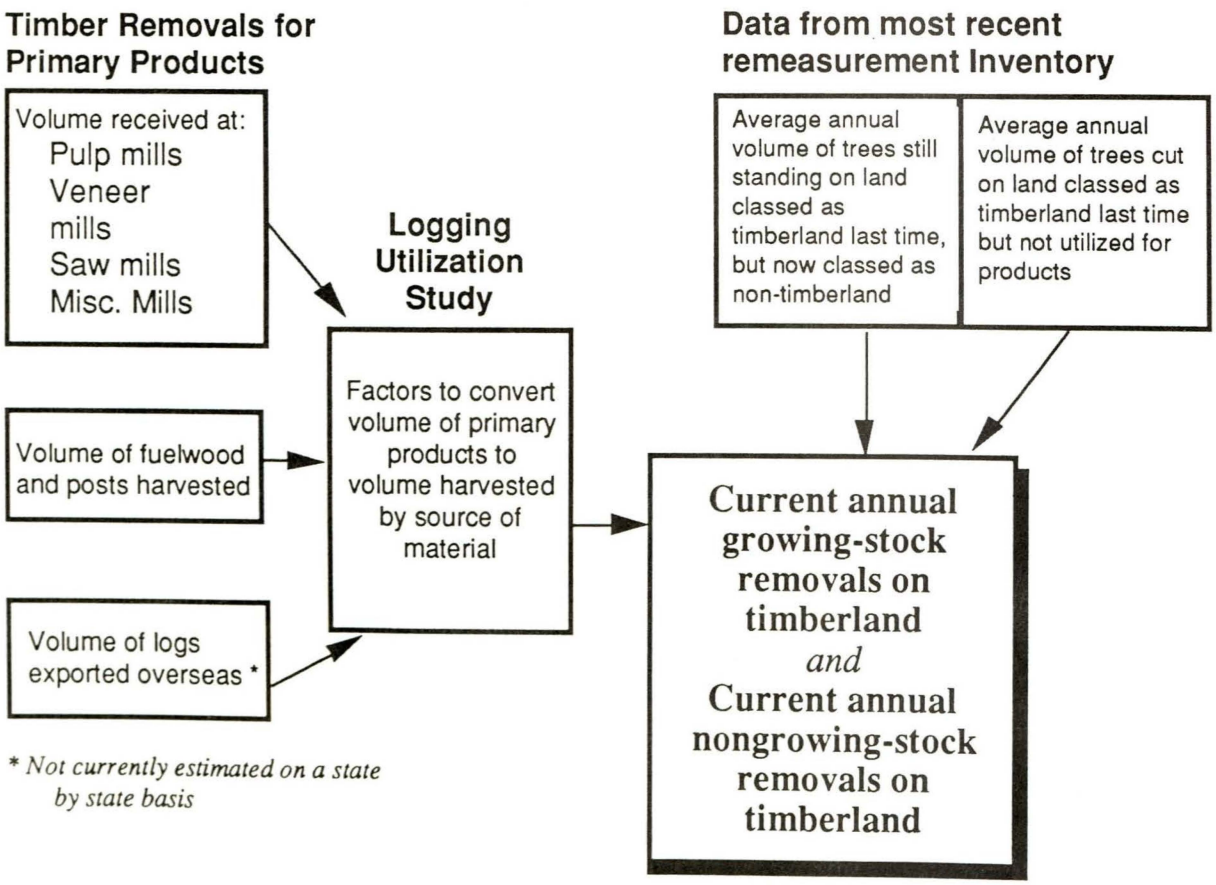

Timber Removals for Primary Products
Volume received at:
Pulp mills
Veneer mills
Saw mills
Misc. Mills
Volume of fuelwood and posts harvested
Volume of logs exported overseas *
Logging Utilization Study
Factors to convert volume of primary products to volume harvested by source of material
Data from most recent remeasurement Inventory
Average annual volume of trees still standing on land classed as timberland last time, but now classed as non-timberland
Average annual volume of trees cut on land classed as timberland last time but not utilized for products
Current annual growing-stock removals on timberland
and
Current annual nongrowing-stock removals on timberland
* Not currently estimated on a state by state basis

Figure 7.— *Components of estimation for current annual removals.*

Table 2.—*Numbers of mills and percent of total receipts of roundwood in North Central subregions*

Subregion	Pulp mills		Saw mills[1]		Other mills	
	Number mills	Percent volume	Number mills	Percent volume	Number mills	Percent volume
Lake States	50	69	804	29	113	3
Central States	3	5	929	88	108	7
Plains States	0	0	119	96	8	4
Total	53	56	1,852	41	229	3

[1] *Mills consistently sawing 50 thousand board feet or more per year.*

Industrial Studies - Wood Harvested for Primary Mills

More than half of the timber removals in the region is consumed by a small number of pulp mills (table 2). Consequently FIA is able to easily canvass these mills annually. Sawmills, although much more numerous than any other type of mill in the region, are canvassed less frequently (generally every 2 to 5 years). Veneer mills are currently canvassed every 2 years. Only that portion of the timber harvest used as raw material is recorded and does not necessarily reflect the total volume of growing stock harvested. Data from logging utilization studies provide the information needed to convert primary product volume to timber removals by source of material.

The forms used by the North Central Station in conducting primary industrial production studies are:

1. Wood Received for Pulp Manufacturing
2. Logs and Other Wood Processed
3. Veneer Logs and Bolts Processed

Samples of the primary study forms are provided in Appendix B of this report. All forms used by North Central FIA to obtain information from the public are approved by the U.S. Office of Management and Budget (OMB).

Primary mill studies are used by FIA to estimate:

1. The quantity of logs and bolts produced in the State by type of product, species group, and Survey Unit or county of origin.
2. The quantity of logs shipped to other States or Canada by product, species group, and area of destination.
3. The quantity of logs received from other States or Canada by product, species group, and area of origin.
4. The number of active mills in the State by type, size, and location.
5. The proportion of wood and bark residue generated at the primary mills in the State by softwoods and hardwoods and by type of disposal or use.

Inventory reports standardize all production statistics to cubic feet, standard cords, or International board feet (1/4-inch scale). Frequently mills in the region will report volumes in other units such as green tons, Doyle board feet, Scribner board feet, or 100-inch cords. Conversion factors used by North Central FIA to convert reported units to standard cord equivalents or International board feet for various products are shown in Appendix C. Factors are also provided to estimate the quantity of mill residue generated based on the reported proportions by residue class and the total volume of roundwood processed by the mill.

General mill canvass - Inventory year procedure

A complete mill canvass is conducted in conjunction with each State forest inventory. This canvass is generally carried out as a cooperative effort with the State forestry agency. State forestry personnel contact and collect data from all in-State mills, and North Central FIA collects data from pulp, veneer, and all out-of-State mills. Data from the annual pulpwood study are transferred to general mill study forms for statewide data processing. Data from the State inventory year canvass are published in the State forest statistics report (Smith and Golitz 1988) and frequently in more detailed timber industry reports (Smith and Dahlman 1990, Smith and Jones 1990, Smith and Whipple 1990).

General mill canvass - Optional midcycle procedure

Frequently a State would like to have full mill canvass data for years between inventories. Even though these studies are cheaper than a new inventory, a complete mill canvass can be time consuming and demanding on personnel. To address this issue North Central FIA has introduced a new mill canvass procedure that greatly reduces the data collection burden with minimal reduction in the accuracy of timber removals estimates (Smith and Whipple 1990). The key to the procedure is in the data processing of the large number of small sawmills that together consume a nominal portion of total timber production. Using the questionnaire titled "Logs and Other Wood Processed," we sample only those larger sawmills that together account for 95 percent of the saw logs processed in the State. Generally this will be 50 to 60 percent of all sawmills in a given State. The remaining sawmills, with production generally less than 500 thousand board feet annually, are contacted only to verify continuing operations and to determine that they have not expanded significantly since the last complete canvass. Data from the previous canvass are repeated for all small mills noting no significant changes. Data are deleted for mills that have ceased operations since the last full canvass. New mills known to have begun operations after the last canvass and currently in operation are sent a form.

Due to the reasonably short interval between State inventories and complete mill canvasses, this procedure allows significant reduction in the collection burden without serious impact on accuracy. Sawmills not canvassed usually comprise less than 2 percent of total production of all products and less than 5 percent of saw log production in the State. During a canvass, industrial fuelwood users that are consuming large volumes of roundwood are identified and treated as if they were a primary mill.

Pulp mill canvass

This canvass has been conducted and results have been published annually by the North Central FIA Unit since 1959 (Hackett and Smith 1990). It includes all primary products made from reconstituted wood—wood pulp, as well as particleboard products made from chips, shavings, wafers, flakes, strands, and sawdust. There were 39 woodpulp and 12 particleboard mills operating in the north central region in 1988. Data are collected from these mills for reporting the production by county of the raw fiber material received. Pulpwood constitutes more than half the industrial timber products harvested annually in the Lake States (Michigan, Minnesota, and Wisconsin) and is an important product in the Central States (Illinois, Indiana, Iowa, and Missouri). Mills outside the region are also canvassed to estimate volumes of north central wood used.

Since 1979, North Central FIA has included logs, bolts, and wood residue used in manufacturing flakeboard, waferboard, oriented strand board, and medium density fiberboard in the annual pulp mill study. Together, these products are called particleboards, and all mills manufacturing these boards are considered particleboard mills. Wood used at particleboard mills is identical or nearly identical to wood

used at pulp mills; therefore, including this wood in the pulpwood study gives a more accurate estimate of demand for pulpwood-like material. Because particleboard mills were in their infancy before 1979, including them after 1979 does not distort roundwood use trends for pulpwood-like material or comparisons of data for current years with those before to 1979.

To avoid redundant collection, data from this canvass are transferred to the general mill study forms if a complete mill canvass is being conducted for a State.

Veneer mill canvass

The veneer log production canvass in the north central region is a continuation of a series begun nearly three decades ago. On a total volume basis, veneer logs are the third most valuable industrial roundwood product harvested in the region. In the early years this canvass was conducted every 2 years, in the mid 1970's it was reduced to every 4 years, and we are currently reviewing a return to the 2-year interval.

Fifty-three veneer mills operated in the region in 1988. Veneer produced here falls into three categories: (1) face veneer for furniture, cabinets, door skins, flooring, etc., (2) commercial veneer for die boards, cross banding, shoe heels, golf club heads, chopsticks, novelty sticks, toothpicks, etc., and (3) packaging or container veneer. As a rule, each mill maintains primary production in just one of these areas using a narrow range of species. A special report on the condition and outlook for the industry is published after each veneer mill canvass (Smith and Hackett 1991).

To avoid redundant collection, data from this canvass are transferred to the general mill study forms if a complete mill canvass is in progress for a State.

Industry and public owner canvass

During a mill canvass in a State inventory year, all wood-using firms and all public agencies owning land in the State are asked to complete the form *"Forest Landownership, Forest Products Logged, and Other Timber Removals"* reporting the log and bolt harvest from their land during the canvass year by type of product and county of origin for softwoods and hardwoods (see form B-4 in Appendix B). This information is used to distribute estimates of current annual removals presented in the State forest statistics reports by product to public and industry ownership classes. The remaining portion of the production for each product is then assumed to come from miscellaneous private owners.

NOTE: *Saw log and veneer log data collected in North Central FIA mill studies reflect only those logs received and processed by mills in the U.S. or Canada and do not include logs exported overseas. In recent years the volume of overseas exports has risen dramatically. National export data show that over 100 exporters shipped more than 150 million board feet of hardwood logs overseas in 1988. Many of these logs came from forests in the north central region. Although it is difficult to determine the volume that came from States in this region, the impact is significant and the volume exported may be more than domestic veneer production. Future studies will quantify the volume of logs exported overseas from States in the north central region.*

Nonindustrial Studies - Residential Fuelwood and Posts

Studies of fuelwood and post production from roundwood are necessary to provide information to forest managers and users about the fuelwood harvest and its impact on the resource. How much fuelwood and how many posts are harvested from forest land? Urban areas? Fence rows and windbreaks? Pastures and cropland? How much comes from public land? Do these products come from growing stock? Are dead trees an important source? Are commercial producers a major source of these products? What are the principal species cut? Where are the principal production areas? Are industrial wood markets threatened by fuelwood and post producers? These studies are necessary because large quantities of fuelwood and posts may be produced and used without passing through commercial markets or processors. Often the producer and consumer are the same person.

The residential fuelwood and post production study is usually completed at the same time as the State inventory with the help of the State forestry agency. During this study, households and loggers are sampled by telephone using a formal questionnaire *"Fuelwood and Post Production"* (see Appendix C, form C-5). The State forestry agency is responsible for data collection and the North Central Station provides forms, training, data processing, and analysis.

The questions in this survey are designed to allow the respondent to provide information, without the use of technical forestry jargon, that can be compared with utilization study data to estimate growing-stock removals from timberland for fuelwood and posts. Respondents who have harvested fuelwood or posts during the 12 months before the interview provide estimates of the volume of fuelwood or number of posts harvested by species, county of origin, and landowner class.

We first determine how much wood came from the following land classes:

1. Inside city or village limits
2. Fencerows, windbreaks, or yards of homes outside city or village limits
3. Pasture or cropland (scattered trees)
4. Woodland areas outside city or village limits, but not including yards of homes
5. Other

For fuelwood or posts that come from rural woodland areas, we also ask how much came from standing live trees, logging waste, dead trees, etc. If the fuelwood or posts are harvested from standing live trees, we ask if tree trunks, limbs, or both were utilized.

The are questions asked in a logical sequence to assist us in estimating the quantity of product that came from growing-stock volume. To be growing-stock material, the product must be from the trunk (bolewood) of standing live trees in rural woodland areas. Logging utilization study factors are used to determine the proportion of live material harvested to allocate to growing-stock and cull trees. North Central FIA encourages followup studies every 5 years if possible to monitor production trends and to evaluate the impact of fuelwood and post harvesting on the growing-stock resource. Although production is the main concern for FIA purposes, we have recently participated in several joint production/consumption study projects and have recently requested approval from OMB to ask consumption questions during future studies. Reports detailing residential fuelwood production are usually published by the North Central FIA Unit after each study (Smith and Weatherspoon 1990).

Logging Utilization Study

The primary mill canvass and the fuelwood and post canvass provide estimates of timber products output. Logging utilization studies provide the factors needed to estimate the volume of wood needed to make these products (Blyth and Smith 1980). These studies take into account merchantable portions of trees left in the woods, logging damage, utilization of nongrowing stock, etc. and are conducted at the time of each new State inventory. Because of limited funding and personnel, however, we must concentrate on those products that comprise a significant portion of industrial roundwood harvest. Usually two or three products account for 90 percent or more of annual production. Utilization factors for products that account for a minor portion of the total harvest are reviewed periodically if funding and personnel permit.

During each study two-person field crews collect felled tree measurement data on a systematically selected random sample of logging operations. On a species group and product basis, the sample trees in an FIA Forest Survey Unit will be close to the estimated proportion of annual harvest in that Unit. Care is taken to ensure that operations are distributed proportionately to ownerships where timber is harvested in each Survey Unit.

Twenty sample trees are measured at each logging site. Each sample tree is put into one of six tree classes:

1. Sawtimber growing-stock
2. Poletimber growing-stock
3. Sapling
4. Rough cull
5. Rotten cull
6. Dead

Crews measure each sample tree in sections from the ground up and record length and diameter-outside-bark at the end of each section. Each section is classified as used for a specific product or as logging residue. Poletimber and sawtimber sections are further classified as growing stock or nongrowing stock.

All limbwood used for products is measured and recorded. Unused limbwood in each tree is estimated by subtracting the volume of used bolewood and limbwood from the total tree volume estimated from biomass equations (Smith 1985). The biomass equations used estimate the total volume of wood fiber in the tree based upon the relationship of combined top and limb volume to gross bole volume by broad species group.

Utilization factors developed from the data collected translate a standard unit of product (thousand board feet of saw logs, cord of pulpwood, etc.) into a common volume unit and type of tree harvested. For each species group, an estimate is made of how much product came from sawtimber growing stock, poletimber growing stock, and nongrowing stock sources such as cull trees, dead trees, saplings, and limbwood. The volume of growing-stock and nongrowing-stock residue generated in producing each product by species group is also estimated.

Personnel selected to conduct logging utilization studies are experienced in taking FIA inventory plot measurements and receive additional training for each utilization study conducted. The crew must be able to visualize and classify each felled tree as if it were standing on an FIA inventory plot. As they measure each tree, the crew accounts for how each portion is cut and utilized by the logger as accurately as possible. The logger is consulted for general specification of utilization standards at the site.

Copies of study plans for all major production and utilization studies are available from the North Central FIA work unit upon request. All information collected from individuals or individual companies is held confidential.

Putting It All Together

Primary mill, fuelwood and post study results in conjunction with the utilization study factors are combined to estimate ***current annual removals*** for products. This is accomplished by multiplying the appropriate logging utilization factor for each product times the volume of that product harvested in the State for the year desired. The term "timber removals" in FIA publications means the volume of products cut from growing stock plus the volume of growing-stock logging residue generated during harvesting. Estimates of ***current annual removals*** also account for the average annual volume of growing-stock trees that have been removed from the timberland base due to a change in land use rather than harvesting. This volume is derived from information collected during a remeasurement inventory.

When enough primary product studies exist for a given State or region, reliable estimates of annual removals can be derived by interpolation for years where product data are missing. This process has been used by the North Central FIA Unit (Smith and Raile 1979, Smith and Hahn 1986, Hahn and Smith 1987, Smith and Hahn 1989).

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APPENDIX A

DEFINITION OF TERMS

Average annual removals from growing stock.—The average net growing-stock volume in growing-stock trees removed annually for forest products (including roundwood products and logging residues) and for other uses (see Other removals). Average annual removals of growing stock are reported for a period of several years (1977 to 1989 in this report) and are based on information obtained from remeasurement plots.

Average annual removals from sawtimber.—The average net board foot sawtimber volume of live sawtimber trees removed annually for forest products (including roundwood products and other uses [see Other removals]). Average annual removals of sawtimber are reported for a period of several years (1977 to 1989 in this report) and are based on information obtained from remeasurement plots.

Commercial species.—Tree species presently or prospectively suitable for industrial wood products. (Note: Excludes species of typically small size, poor form, or inferior quality such as hophornbeam, osage-orange, and redbud.)

Commercial forest land.—(See Timberland.)

Cord.— One standard cord is 128 cubic feet of stacked wood, including bark and air space. Cubic feet can be converted to standard cords by dividing by 79.

County and municipal land.—Land owned by counties and local public agencies or municipalities, or land leased to these governmental units for 50 years or more.

Cull.—Portions of a tree that are unusable for industrial wood products because of rot, missing or dead material, or other defect.

Cull tree.—A tree that does not meet the standards of growing stock because of poor form, rot, missing or dead material, or other defect.

Diameter class.—A classification of trees based on diameter outside bark, measured at breast height (d.b.h.). Two-inch diameter classes are commonly used in Forest Inventory and Analysis, with the even inch the approximate midpoint for a class. For example, the 6-inch class includes trees 5.0 through 6.9 inches d.b.h.

Forest land.—Land at least 16.7 percent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use. (Note: Stocking is measured by comparing specified standards with basal area and/or number of trees, age or size, and spacing.) The minimum area for classification of forest land is 1 acre. Roadside, streamside, and shelterbelt strips of timber must have a crown width of at least 120 feet to qualify as forest land. Unimproved roads and trails, streams, or other bodies of water or clearings in forest areas shall be classed as forest if less than 120 feet wide.

Forest industry land.—Land owned by companies or individuals that operate a primary wood-using plant.

Growing-stock tree.—A live tree of commercial species that meets specified standards of size, quality, and merchantability. (Note: Excludes rough, rotten, and dead trees.)

Growing-stock volume.—Net volume in cubic feet of growing-stock trees 5.0 inches d.b.h. and over, from 1 foot above the ground to a minimum 4.0 inch top diameter outside bark of the central stem or to the point where the central stem breaks into limbs.

Hard hardwoods.—Hardwood species with an average specific gravity greater than 0.50 such as oaks, hard maple, hickories, and ash.

Hardwoods.—Dicotyledonous trees, usually broad-leaved and deciduous. (See Soft hardwoods and Hard hardwoods.)

Industrial wood.— All roundwood products, except fuelwood.

Logging residues.—The unused portions of trees cut or killed by logging.

Merchantable.—Refers to a pulpwood or saw-log section that meets pulpwood or saw-log specifications, respectively.

Miscellaneous private land.—Privately owned land other than forest-industry and farmer-owned land.

Mortality.—The volume of sound wood in growing-stock and sawtimber trees that die annually.

National Forest land.—Federal land that has been legally designated as National Forest or purchase units, and other land administered by the USDA Forest Service.

Noncommercial species.—Tree species of typically small size, poor form, or inferior quality that normally do not develop into trees suitable for industrial wood products.

Nonforest land.—Land that has never supported forests, and land formerly forested where use for timber management is precluded by development for other uses. (Note: Includes areas used for crops, improved pasture, residential areas, city parks, improved roads of any width and adjoining clearings, powerline clearings of any width, and 1- to 40-acre areas of water classified by the Bureau of the Census as land. If intermingled in forest areas, unimproved roads and nonforest strips must be more than 120 feet wide and more than 1 acre in area to qualify as nonforest land.)

a. *Nonforest land without trees.*—Nonforest land with no live trees present.
b. *Nonforest land with trees.*—Nonforest land with one or more trees per acre at least 5 inches d.b.h.

Other federal land.—Federal land other than National Forest.

Other removals.—Growing-stock trees removed but not utilized for products, or trees left standing but "removed" from the timberland classification by land use change. Examples are removals from cultural operations such as timber stand improvement work, land clearing, and changes in land use.

Plant byproducts.—Plant residues used for products such as mulch, pulp chips, and fuelwood.

Plant residues.—Wood and bark materials generated at manufacturing plants during production of other products.

Poletimber tree.—A tree at least 5.0 inches d.b.h. but smaller than sawtimber size.

Reserved forest land.—Forest land withdrawn from timber utilization through statute, administrative regulation, designation, or exclusive use for Christmas tree production, as indicated by annual shearing.

Roundwood products.—Logs, bolts, or other round sections (including chips from roundwood) cut from trees for industrial or consumer uses. (Note: Includes saw logs, veneer logs and bolts; cooperage logs and bolts; pulpwood; fuelwood; piling; poles; posts; hewn ties; mine timbers; and various other round, split, or hewn products.)

Rotten tree.—A tree that does not meet regional merchantability standards because of excessive unsound cull. May include noncommercial tree species.

Rough tree.—A tree that does not meet regional merchantability standards because of excessive sound cull. May include noncommercial tree species.

Salvable dead tree.—A standing or down dead tree considered merchantable by regional standards.

Sapling.—A live tree 1.0 to 5.0 inches d.b.h.

Saw log.—A log meeting minimum standards of diameter, length, and defect, including logs at least 8 feet long, sound and straight and with a minimum diameter outside bark (d.o.b.) for softwoods of 7.0 inches (9.0 inches for hardwoods) or other combinations of size and defect specified by regional standards.

Saw-log portion.—That part of the bole of sawtimber trees between the stump and the saw-log top.

Sawtimber tree.—A tree of commercial species containing at least a 12-foot saw log or two noncontiguous saw logs 8 feet or longer, and meeting regional specifications for freedom from defect. Softwoods must be at least 9.0 inches d.b.h. Hardwoods must be at least 11.0 inches d.b.h.

Sawtimber volume.—Net volume of the saw-log portion of live sawtimber in board feet, International 1/4-inch rule (unless specified otherwise) from stump to a minimum 7 inches top diameter outside bark (d.o.b.) for softwoods and a minimum 9 inches top d.o.b. for hardwoods.

Short-log (rough tree).—Sawtimber-size trees of commercial species that contain at least one merchantable 8- to 11-foot saw log but not a 12-foot saw log.

Soft hardwoods.—Hardwood species with an average specific gravity less than 0.50 such as gum, yellow-poplar, cottonwood, red maple, basswood, and willow.

Softwoods.—Coniferous trees, usually evergreen, having needles or scale-like leaves.

State land.—Land owned by States or leased to them for 50 years or more.

Timberland.—Forest land that is producing or capable of producing in excess of 20 cubic feet per acre per year of industrial wood crops under natural conditions, that is not withdrawn from timber utilization, and that is not associated with urban or rural development. Currently inaccessible and inoperable areas are included.

Timber removals from growing stock.—The net volume of growing stock in growing-stock trees removed for forest products (including roundwood products and logging residues) and for other uses (see Other removals). Timber removals from growing stock are reported for a single year and are based on information obtained from a survey of primary wood-using mills.

Timber removals from sawtimber.—The net board-foot volume of live sawtimber trees removed for forest products (including roundwood products and logging residues) and for other uses (see Other removals). Timber removals from sawtimber are reported for a single year (1988 in this report) and are based on information obtained from a survey of primary wood-using mills.

Timber products output.—All timber products cut from roundwood and byproducts of wood manufacturing plants. Roundwood products include logs, bolts, or other round sections cut from growing-stock trees, cull trees, salvable dead trees, trees on nonforest land, noncommercial species, sapling-size trees, and limbwood. Byproducts from primary manufacturing plants include slabs, edging, trimmings, miscuts, sawdust, shavings, veneer cores and clippings, and screenings of pulpmills that are used as pulpwood chips or other products.

APPENDIX B

FORMS and QUESTIONNAIRES

FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE
North Central Forest Experiment Station
1992 Folwell Avenue
St. Paul, Minnesota 55108

Form Approved
OMB No. 0596-0010

WOOD RECEIVED FOR PULP MANUFACTURING
Calendar Year 19____

Plant Name: _____

Mailing Address: _____
(City) (County) (State) (Zip Code)

Plant Location: _____
(City) (County) (State) (Zip Code)

Instructions: This form is for reporting the quantity of pulpwood—roundwood, chips, sawdust, and other byproducts—received by this plant during 19____, and the disposition of bark from unpeeled pulpwood. This survey is authorized by PL 93-378 as amended by PL 94-588. Your cooperation is appreciated and needed to make the results of this survey complete, accurate, and timely, although you are not required to respond.

Please complete the form and return it promptly in the accompanying envelope which requires no stamp. If complete records are not available, please give your best estimates. Do not include logs, bolts, or chips sold or transferred to another plant.

All replies will be held confidential and will be used only for statistical reports.

☐ Check here if you wish to receive a copy of the report resulting from this study.

Person to be contacted if necessary regarding this report.

Name _____ Title _____

Telephone Number AC(____) _____ Date _____

NORTH CENTRAL FOREST EXPERIMENT STATION
Forest Service, U.S. Department of Agriculture
1992 Folwell Avenue
St. Paul, Minnesota 55108

Form Approved
OMB No.
0596-0010

VENEER LOGS AND BOLTS PROCESSED IN 1990

This form is for reporting the quantity of veneer logs and bolts processed by this plant in 1988, and the disposition of the wood residues resulting from this operation. All replies will be held confidential and used only for aggregate statistical reports.

☐ Check here if you wish to receive a copy of the report resulting from this study.

Plant or company name: _____

Mailing address: _____

Plant location: _____ County

Person to contact about this report: _____

Telephone No. (_____) _____

Plant operation in 1990 (Check one).

☐ Full time
☐ Part time
☐ Closed
☐ Sold

If plant was **sold** or closed, please report only those logs and bolts processed during **1990** before the plant was sold or discontinued operations. Give the new owners name and address in the **Remarks** section on page 3 of this form.

☐ Check here if no veneer logs or bolts processed in **1990** and return the form.

Equipment
(check all that apply)

☐ Rotary slice
☐ Half-round slice
☐ Flat slice
☐ Other_____

Primary products *(check all that apply)*

Commercial

☐ Basket
☐ Core
☐ X Banding
☐ Other_____

Face veneer

☐ Architectural
☐ Furniture
☐ Panel
☐ Other _____

DO NOT WRITE IN THIS BLOCK

Cols. 1-5 = **61100**

MILL	STATE	COUNTY
XXX	XX	XXX
6-8	9-10	11-13

Product
XX
02
14-15

Factor
XXX
47-49

A pre-addressed envelope is provided for your convenience.

This survey is authorized by PL 93-378 as amended by PL 94-588. Your cooperation is appreciated and needed to make the results of this survey comprehensive, accurate, and timely, although you ar not required to respond.

Section I. **VENEER LOGS AND BOLTS PROCESSED IN 1990.**

Do not include logs or bolts sold or transferred to other companies*. Enter the total quantity of logs and/or bolts processed opposite species in the first column. In the remaining colums indicate the state and county, or state(s) outside the region (see enclosed map of North Central region, figure 1), or Canada where the logs and/or bolts were harvested. If you do not know the exact county the logs or bolts where harvested, please indicate the area of the state by using the code numbers on the enclosed map. An example, southeast Minnesota around the Iowa and Wisconsin border would be listed Minnesota, 273b in the column heading. A sample of how to enter the data is shown on the reverse side of the enclosed map sheet.

If the unit of measure is board feet, indicate the log rule below.
If cords, specify size _____. If weight, specify pounds per thousand board feet _____ or pounds per cord _____.

Cols. 1-5 = 622xx or 623xx

Species	Unit of measure: Doyle log rule ☐ Scribner rule ☐ Doyle-Scribner ☐ International 1/4 ☐ Cords ☐ Other ☐ _____	Quantity processed from each State and county, or State(s) outside the region, or Canada (enter name of State and country or code in column headings)							
	TOTAL QUANTITY PROCESSED. If board feet record in thousands.	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
Domestic conifers (specify):	1								
	2								
Domestic Hardwoods: Ash	3								
Aspen (popple)	4								
Basswood	5								
Beech	6								
Black cherry	7								
Butternut	8								
Cottonwood	9								
Elm	10								
Gum	11								
Hard maple	12								
White birch	13								
Pecan (hickory)	14								
Red oak	15								
Soft maple	16								
Sycamore	17								
Walnut	18								
White oak	19								
Yellow birch	20								
Yellow-poplar	21								
Other (specify)									
FOREIGN SPECIES:									
TOTAL									

Cols. 27-46 blank

Section 1. continued on the next page.

*If you sold or transferred logs or bolts to a mill outside the seven state region on the map, please indicate below:

Company:	Location

Cols. 1-5 = 622xx or 623xx

Species		Quantity processed from each State and county, or State(s) outside the region, or Canada (enter name of State and county or code in column headings)									
		XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
Domestic conifers (specify):	1										
	2										
Domestic Hardwoods: Ash	3										
Aspen (popple)	4										
Basswood	5										
Beech	6										
Black cherry	7										
Butternut	8										
Cottonwood	9										
Elm	10										
Gum	11										
Hard maple	12										
White birch	13										
Pecan (hickory)	14										
Red oak	15										
Soft maple	16										
Sycamore	17										
Walnut	18										
White oak	19										
Yellow birch	20										
Yellow-poplar	21										
Other (specify)											
FOREIGN SPECIES:											
TOTAL											

Cols. 27-46 blank

Cols. 1-5=71100

SECTION I. ROUNDWOOD AND CHIPS FROM ROUNDWOOD RECEIVED

XXXX Cols. 6-9 Origin of pulpwood

Col. 10 (Check unit of measure in which reported) 1 ☐ 4' × 4' × 96" (128 cu. ft.) cord 2 ☐ 4' × 4' × 100" cord 3 ☐ Green tons ☐ Other (Specify)_____

State	Code	County or foreign country	Code	Cedar 01	Fir, Balsam 02	Hemlock 03	Pine, jack 04	Pine, red 05	Pine, white 06	Spruce 07	Tamarack 08	Ash 09	Aspen 10	Balm-of-Gilead 11	Basswood 12	Beech 13	Birch, white 14	Birch, yellow 15	Cottonwood 16	Elm 17	Hickory 18	Maple, hard 19	Maple, soft 20	Oak, Red 21	Oak, White 22	Other species (Specify)
	XX		XXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX

SECTION II. PLANT BYPRODUCTS RECEIVED FOR USE AS PULPWOOD
(Indicate Unit of Measure in Table Below)

Cols. 1-5 = 71200 Dup Cols. 6-9 Col. 10 = 5 Cols. 16-17 = 97 Col. 23 blank

Origin of byproduct		Wood chips		Sawdust		Other byproducts*	
State or foreign country	Code XXXXX	Conifer XXXXX	Hardwood XXXXX	Conifer XXXXX	Hardwood XXXXX	Conifer XXXXX	Hardwood XXXXX

Unit of Measure Used Above in Reporting Plant Byproducts
(Check appropriate box)

Unit of Measure		Wood chips from plant byproducts Col. 49	Sawdust Col. 50	Other byproducts Col. 51
Standard cord (128 cu. ft.)	1	☐	☐	☐
Cunits	2	☐	☐	☐
Ovendry tons	3	☐	☐	☐
Green tons	4	☐	☐	☐
Other (specify)	5	_____	_____	_____

*Specify type of other byproduct_____
(Veneer cords, pole ends, slabwood, etc.)

SECTION III. DISPOSITION OF BARK

Instructions: Please enter your best estimate of the percentage of bark that was used for the various purposes indicated.

Cols. 1-5=71590

Disposition of bark		1 XX Conifer (Percent)	2 XX Hardwood (Percent)
1. USED FOR: a. Manufacture of fiber products such as pulp, hardboard, or roofing felt	1		
b. Industrial fuel at this or other plants	3		
c. Domestic household fuel—sold or given away	4		
d. Miscellaneous uses such as livestock bedding, mulch, small dimension, and speciality items	5		
2. NOT USED (including bark burned as waste)	6		
3. TOTAL		100%	100%

SECTION IV. BARK SOLD OR USED.

Instructions: Please enter your best estimate of the total quantity of bark sold or given away to other companies or individuals or used by your company.

Unit of measure	Total quantity of bark sold, used, or given away	
	Conifer	Hardwood
1. Cubic feet		
2. Green tons		
3. Dry tons		

Section II. DISPOSAL OF PLANT RESIDUES IN 1990 BY TYPE AND USE

Instructions: Please enter your best estimate of the **percentage of each type of plant residue** that was used for the various purposes indicated

Cols. 1-5 = 6259x

DISPOSAL OF RESIDUE	BARK		COARSE RESIDUES (Suitable for chipping such as slabs, edgings, etc.)		FINE RESIDUES (Sawdust, veneer, clippings, etc. not suitable for chipping)	
	1 Conifer	2 Hardwood	3 Conifer	4 Hardwood	5 Conifer	6 Hardwood
	x x	x x	x x	x x	x x	x x
1. USED FOR:						
a. Manufacture of fiber products such as pulp, hardboard, or roofing felt 1	%	%	%	%	%	%
b. Charcoal or chemical wood 2	%	%	%	%	%	%
c. Industrial fuel at this or other mill 3	%	%	%	%	%	%
d. Domestic household fuel -- sold or given away 4	%	%	%	%	%	%
e. Miscellaneous uses such as livestock bedding, mulch, small dimension, and specialty items. 5	%	%	%	%	%	%
2. NOT USED: (Including land fill and residues burned as waste. 6	%	%	%	%	%	%
3. TOTAL	100 %	100 %	100 %	100 %	100 %	100 %

Section III. Material sold to the pulp industry in 1990, by type:

		Conifers	Hardwoods
1. Total quantity sold	Cords	_____	_____
	or Tons	_____	_____
2. Of the total quantity sold, what percent was from:			
a. Coarse residues		_____	_____
b. Fine residues		_____	_____
c. Roundwood chipped at plant (excluding cores)		_____	_____
		100%	100%

Remarks: _____

_____

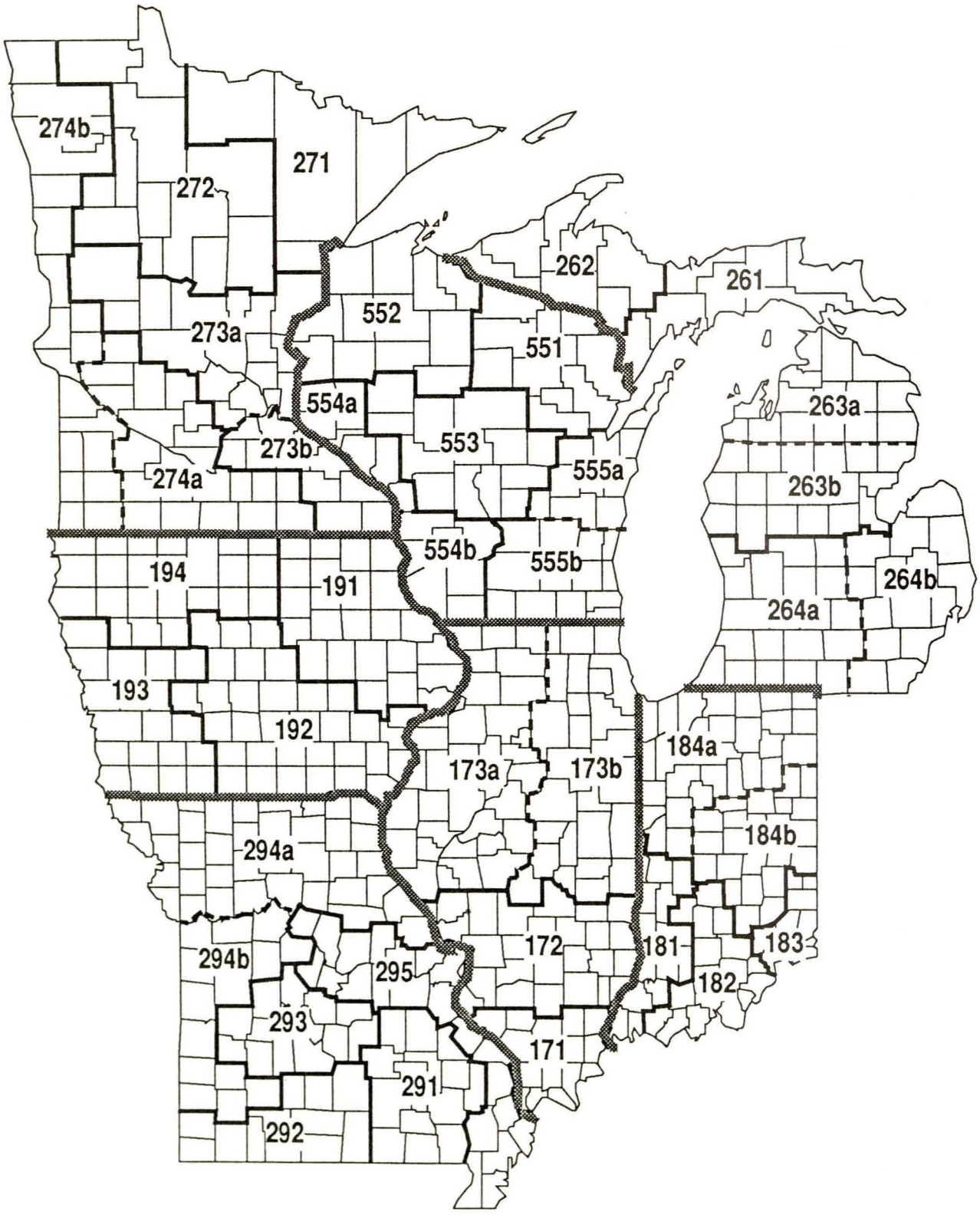


Figure 1. Forest Survey Units and subunits in the North Central Region.

[Sample sheet on reverse side.]

Form Approved
OMB No. 0596-0010

LOGS AND OTHER WOOD PROCESSED IN 1990

MICHIGAN

This form is for reporting the quantities and kinds of logs and other wood processed by this plant in 1990, and the disposition of the wood residues resulting from this operation.

All replies will be held confidential and used only for statistical reports.

☐ Check here if you wish to receive a copy of the report resulting from this study.

Plant or company name: _____

Mailing address: _____

Plant location: _____ County

Person to contact about this report: _____

Types of wood processed in 1990. *Check only one kind of product. If more than one kind was received, fill out a separate form for each.*

14-15

01	☐	Saw logs & bolts-- includes veneer logs sawn
02	☐	Veneer logs & bolts cut into veneer
03	☐	Cooperage logs and bolts
06	☐	Piling
07	☐	Poles
09	☐	Industrial fuelwood
10	☐	Posts
11	☐	Charcoal wood
12	☐	Other (specify) _____

☐ Check here if no wood was processed in 1990 and return the form.

Total volume of above-checked product that was processed in 1990.

Conifer (pine, cedar, etc.) _____ Hardwood (includes cottonwood) _____

27-36 37-46

DO NOT WRITE IN THIS BLOCK

Cols. 1-5 = 61100

MILL	STATE	COUNTY
XXX	XX	XXX
6-8	9-10	11-13

FACTOR
XXX
47-49

MILL SIZE
X
50

A pre-addressed envelope is provided for your convenience.

This survey is authorized by PL 93-378 as amended by PL 94-588. Your cooperation is appreciated and needed to make the results of this survey comprehensive, accurate, and timely, although you are not required to respond.

LOGS and OTHER WOOD PROCESSED IN 1990.

Do not include logs or bolts sold or transferred to other companies. Enter quantity processed opposite species in appropriate columns showing survey units, other states and Canada where the logs and bolts were harvested. The State map on page 4 shows unit boundaries. If the unit of measure is board feet, indicate the log rule or lumber tally. ☐ Doyle ☐ International ☐ Scribner ☐ Lumber tally
If cords, specify size _____. If weight, specify pounds per thousand board feet _____ or pounds per cord _____.

Cols. 1-5 = 612xx or 613xx

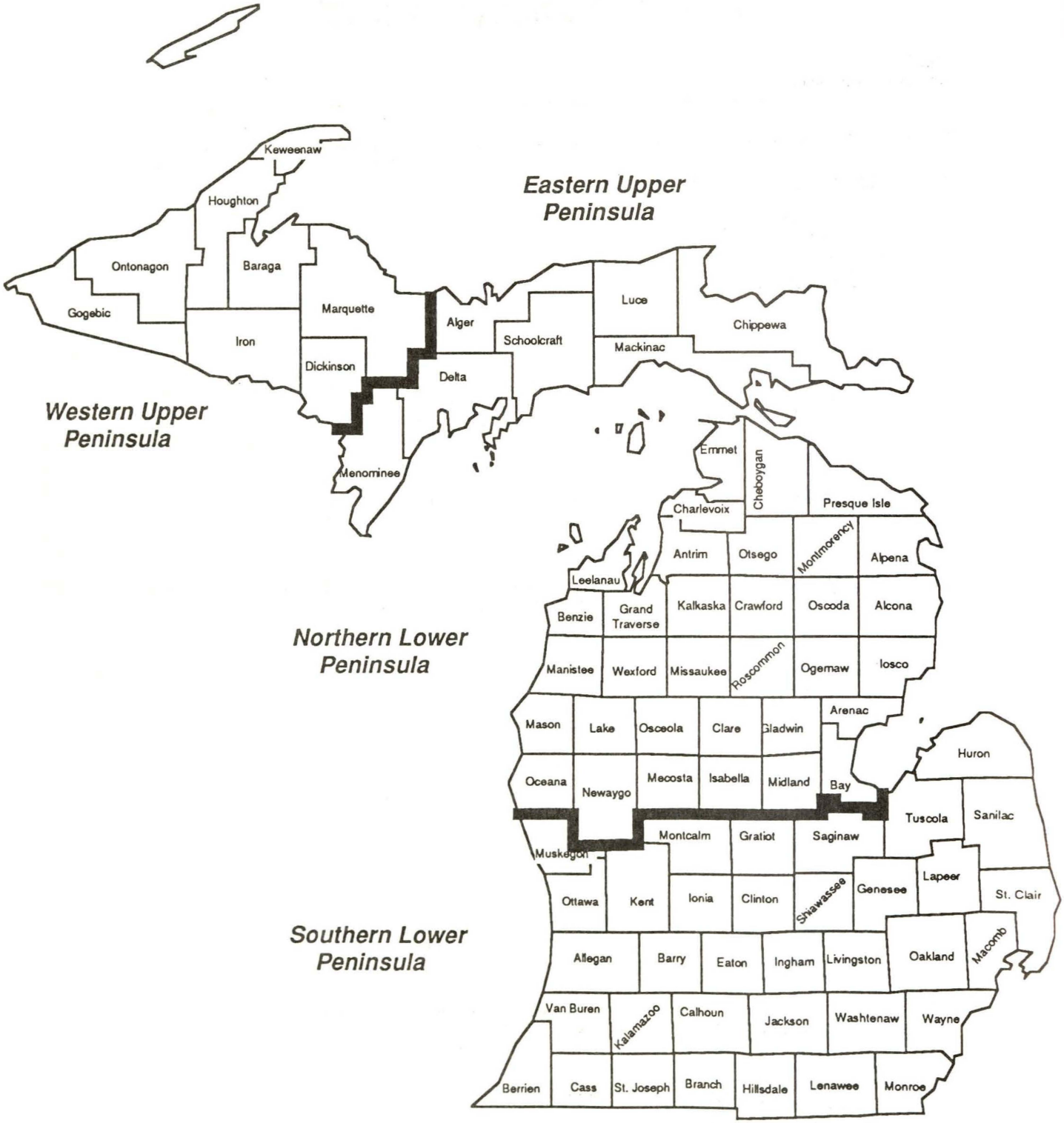
Species	Unit of measure: ☐ Board feet ☐ Cords ☐ Cubic feet ☐ Lineal feet ☐ Pieces ☐ Weight ☐ Other _____		FROM MICHIGAN (enter name of county immediately below)								OTHER STATES AND CANADA (enter name below)	
			XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
Cedar	1											
Balsam fir	2											
Hemlock	3											
Jack pine	4											
Red pine	5											
White pine	6											
Spruce	7											
Tamarack	8											
Ash	9											
Aspen	10											
Balsam poplar	11											
Basswood	12											
Beech	13											
White birch	14											
Yellow birch	15											
Cottonwood	16											
Elm	17											
Hickory	18											
Hard maple	19											
Soft maple	20											
Red oak	21											
White oak	22											
Walnut	23											
Other (specify)	24											
TOTAL												

DISPOSAL OF PLANT RESIDUES IN 1990 BY TYPE AND USE, for product checked on page 1

Instructions: Please enter your best estimate of the **percentage of each type of plant residue** that was used for the various purposes indicated

Cols. 1-5 = 615xx

DISPOSAL OF RESIDUE	BARK		COARSE RESIDUES (Suitable for chipping such as slabs, edgings, etc.)		FINE RESIDUES (Sawdust, veneer, clippings, etc. not suitable for chipping)	
	1 Conifer	2 Hardwood	3 Conifer	4 Hardwood	5 Conifer	6 Hardwood
	XX	XX	XX	XX	XX	XX
1. USED FOR:						
a. Manufacture of fiber products such as pulp, hardboard, or roofing felt 1	%	%	%	%	%	%
b. Charcoal or chemical wood 2	%	%	%	%	%	%
c. Industrial fuel at this or other mill 3	%	%	%	%	%	%
d. Domestic household fuel -- sold or given away 4	%	%	%	%	%	%
e. Miscellaneous uses such as livestock bedding, mulch, small dimension, and specialty items. 5	%	%	%	%	%	%
2. NOT USED: (Including land fill and residues burned as waste. 6	%	%	%	%	%	%
3. TOTAL	%	%	%	%	%	%


Keweenaw
Houghton
Ontonagon
Baraga
Gogebic
Marquette
Iron
Dickinson
Alger
Schoolcraft
Delta
Luce
Mackinac
Chippewa
Menominee
Eastern Upper Peninsula
Western Upper Peninsula
Northern Lower Peninsula
Southern Lower Peninsula
Emmet
Cheboygan
Presque Isle
Charlevoix
Antrim
Otsego
Montmorency
Alpena
Leelanau
Benzie
Grand Traverse
Kalkaska
Crawford
Oscoda
Alcona
Manistee
Wexford
Missaukee
Roscommon
Ogemaw
Iosco
Arenac
Mason
Lake
Osceola
Clare
Gladwin
Huron
Oceana
Newaygo
Mecosta
Isabella
Midland
Bay
Tuscola
Sanilac
Montcalm
Gratiot
Saginaw
Muskegon
Ottawa
Kent
Ionia
Clinton
Shiawassee
Genesee
Lapeer
St. Clair
Allegan
Barry
Eaton
Ingham
Livingston
Oakland
Macomb
Van Buren
Kalamazoo
Calhoun
Jackson
Washtenaw
Wayne
Berrien
Cass
St. Joseph
Branch
Hillsdale
Lenawee
Monroe

FORM APPROVED
OMB No. 0596-0010

FOREST LANDOWNERSHIP, FOREST PRODUCTS LOGGED, AND OTHER TIMBER REMOVALS, Michigan, 1990

Cols 1-2 = 70
Agency or firm name: _____

Mailing address: _____
(Street) (City) (State) (Zip code)

Do not write in this block			
ON	SN	OC	State
3-5	6-7	8-9	10-11

Instructions: This form is for reporting for each Michigan county, the acres of forest land you owned in 1990, the quantities of forest products logged from your land, and the quantity of timber removed from your land by clearing, reservoir development, ponding, etc., that was not used for products.

This survey is authorized by PL 93-378 as amended by PL 94-588. Your cooperation is appreciated and needed to make results of this survey comprehensive, accurate, and timely, although you are not required to respond. All replies will be held confidential and will be used only for statistical reports.

Please complete the form and return it promptly in the accompanying addressed stamped envelope. If complete records are not available, please give your best estimate.

1. Number of acres of Michigan forest land owned in 1990 by county:

County	
_____	_____ acres
_____	_____ acres
_____	_____ acres
_____	_____ acres

☐ Check here if no Michigan forest land was owned. Return form.

2. Did you or anyone else cut forest products from your Michigan forest land or remove trees that were not used for products (timber removed and piled, piled and burned, etc.) from your forest land in 1990? (check one)

☐ Yes, complete back of this form.

☐ No, return form.

Person to be contacted if necessary regarding this report:

Name: _____ Title: _____

Telephone number: AC ( ) _____ Date: _____

Cols 1-2 = 71

3. Record the quantity of timber products cut or other removals from your **Michigan** forest land in 1990 by county. Other removals includes timber removed anmd piled, piled and burned, etc., that was not used for products.

Timber removals and other removals from your Indiana forest land	Code x x x	Unit of measure	Enter name of county and quantity removed from each							
			Conifers	Hardwoods	Conifers	Hardwoods	Conifers	Hardwoods	Conifers	Hardwoods
Saw log products: 01 Sawlogs										
02 Veneer logs										
03 Cooperage logs										
04 Mine timbers										
Other (specify):										
Cordwood products: 01 Box bolts										
05 Pulpwood										
09 Fuelwood										
11 Charcoal wood										
Other (specify):										
Piece products: 07 Poles, utility										
06 Piling										
10 Posts										
01 Tie cuts										
Other (specify):										
Other removals (not used for products)										

Form Approved
OMB No. 0596-0009
(Exp. Dec. 31, 1991)

Fuelwood Production
Michigan, 1990

COVER SHEET - HOUSEHOLD SAMPLE

Phone # (AC)

1. I'm (YOUR NAME) calling for the Michigan Department of Natural Resources in East Lansing, Michigan. Is this (TELEPHONE NUMBER)?

   ☐ Yes ☐ No ***(Terminate call)***

2. Is this a residential number?

   ☐ Yes ☐ Yes, but no adult available ***(Go to Q 6)*** ☐ Yes, but also non-residential ***(Go to Q 6)*** ☐ No ***(Terminate call)***

3. We are doing a statewide survey in cooperation with the U.S. Forest Service to determine the quantity of fuelwood harvested in Michigan and the impact of its production on the forest resource. Over the last twelve months, have you or a member of your household cut or collected any fuelwood in Michigan right on the land it was grown?

   ☐ Yes ☐ No ***(Terminate call)***

4. May I speak with the person in your household who knows the most about the amount and kind of fuelwood that was cut by a member(s) of your household in Michigan during the last twelve months?

   ☐ Informat is respondent or respondent comes to phone ☐ Respondent not availabe ***(To Q 6)*** ☐ Refuesed ***(Terminate call)***

5. (EXPLAIN AS NECESSARY) I would like to ask you some questions about your household's production of fuelwood. The time required should not be more than 10 minutes.

   ☐ Respondent will start now ***(to Fuelwood Questionnaire)*** ☐ Respondent will not start now ***(Go to question 6)***

6. When would be the best time to phone (YOUR HOUSEHOLD/DESIGNED RESPONDENT) (and) whom should we ask for when we call again)?

Respondent Identification	When to Call Mo.	Day	Time	Comments

Form Approved
OMB No. 0596-0009
(Exp. Dec. 31, 1991)

Fuelwood Production
Michigan, 1990

(Household Sample)

Sample #

[ ][ ][ ][ ]

1 - 4

Residence address (County): _____

Interviewer: _____

Date: _____ Time required: _____minutes

I WANT TO ASSURE YOU THAT ALL OF THE INFORMATION YOU GIVE US IS CONFIDENTIAL, AND THAT NONE OF IT WILL BE RELEASED IN ANY WAY THAT WOULD PERMIT IDENTIFICATION OF YOUR HOUSEHOLD. YOUR PARTICIPATION IS VOLUNTARY. WHILE YOU ARE NOT REQUIRED TO RESPOND, YOUR COOPERATION IS NEEDED TO MAKE THE SURVEY RESULTS COMPREHENSIVE, ACCURATE, AND TIMELY. THANK YOU.

1. A standard cord is a stack of wood four feet high, four feet deep, and eight feet wide. A face cord is a stack of stove length pieces four feet high and eight feet wide. How many standard cords or face cords of fuelwood did you cut or collect during the last 12 months in Michigan from land where it was grown? Please include fuelwood sold, given away, or for your own use.

Standard cords: [1] One or less *(Go to Q 2)* [2] _____cords *(Go to Q 5)*

Face cords:. [3] _____cords *(Go to Q 3)* [4] Don't know *(Go to Q 4)*

[ ]
5

[ ][ ][ ][ ][ ]
6 - 10

2. Was the amount of fuelwood you cut or collected in Michigan during the last 12 months no more than 50 pieces, or about 100, 150, 200, or 300 pieces?

[1] 50 [2] 100 [3] 150 [4] 200 [5] 300 [6] Don't know

[ ]
11

If you completed question 2 go to question 5.

3. On the average, were these face cords about 12 inches in length, 16 inches, 18 inches, or 24 inches?

[1] 12" [2] 16" [3] 18" [4] 24" [5] Other _____ (specify)

[ ]
12

If you completed question 3 go to question 5.

AMOUNT	UNIT CODE
☐☐☐ 13 - 15	☐☐ 16 - 17
☐☐☐ 18 - 20	☐☐ 21 - 22

4. Could you tell me about how much fuelwood did you cut or collect in Michigan during the last 12 months?

(Interviewer: See Unit Codes below).

UNIT CODES

01. 3/4 ton pickup
02. 1/2 ton pickup
03. Small pickup truck (Nissan, Toyota, Ranger, S-10,etc.)
04. Full size car trunk
05. Small size car trunk
06. Suburban (Carryall)
07. Full size van
08. Small size van
09. Full size station wagon
10. Small station wagon
11. Small hatchback
12. Pounds: green wood
13. Pounds: dry wood
14. Tons: green wood
15. Tons: dry wood
16. Cubic feet
17. Cords: 4'x8'x12"
18. Cords: 4'x8'x16"
19. Cords: 4'x8'x18"
20. Cords: 4'x8'x24"
21. Cords: 4'x8'x4'
22. Bundles
23. 5 inch trees
24. 10 inch trees
25. 15 inch trees
26. 20 inch trees
27. 25 inch trees
28. 30 inch trees
29. 40 inch trees
66. Other response: (specify)_____
99. Don't know

5. What percent of this fuelwood your household cut was from

(nearest percent)

Total = 100%

☐ Trees inside city or village limits? ☐☐ % 23 - 24

☐ Fence rows, windbreaks, or yards of homes outside city or village limits? ☐☐ % 25 - 26

☐ Scattered trees on pasture or cropland? ☐☐ % 27 - 28

☐ Woodland areas outside city or village limits, but not including the yards of homes? ☐☐ % 29 - 30

☐ Other (specify)?_____ ☐☐☐ % 31 - 33

If woodland areas are a source, go to Question 6; if not go to Question 8.

(nearest percent)

6. What percent of this fuelwood cut from woodland areas was from

Total = 100%

Standing live trees? ☐☐ % (34 - 35)

Logging waste or wood left over from logging? ☐☐ % (36 - 37)

Dead trees, standing or down? ☐☐ % (38 - 39)

Other (specify)? _____ ☐☐☐ % (40 - 42)

If standing live trees are a source, go to question7; if not go to question 8.

7. In the woodland areas, after the standing live trees were harvested, was the fuelwood cut from the trees'

☐1 Trunks? ☐2 Limbs? ☐3 Both? ☐ (43)

8. What species of timber did your household cut for fuelwood in the last 12 months? What percent of the total came from each of these species?

(nearest percent)

Total = 100%

☐ Oak ☐☐ % (44 - 45)

☐ Maple ☐☐ % (46 - 47)

☐ Elm ☐☐ % (48 - 49)

☐ Birch ☐☐ % (50 - 51)

☐ Aspen (Popple) ☐☐ % (52 - 53)

☐ Other (specify):

_____ ☐☐☐☐ % (54 - 57)

_____ ☐☐☐☐ % (58 - 61)

_____ ☐☐☐☐ % (62 - 65)

9. In what counties did your household cut fuelwood during the last 12 months? What percent came from each county?

(nearest percent)
Total = 100%

_____ ☐☐☐☐☐ % 66 - 70

_____ ☐☐☐☐☐ % 71 - 75

_____ ☐☐☐☐☐ % 76 - 77

10. During the last 12 months, what percent of the fuelwood you cut came from:

(nearest percent)
Total = 100%

Land owned by a company that produces lumber, pulp, veneer, or other forest products? ☐☐ % 81 - 82

Your own property or other private .land? ☐☐ % 83 - 84

National Forest land? ☐☐ % 85 - 86

Other Federal land? (Specify Federal Agency) _____ ☐☐☐ % 87 - 89

State land? ☐☐ % 90 - 91

County and municipal land? ☐☐ % 92 - 93

Sample #

☐☐☐☐

1 - 4

Post Production
Michigan, 1990

(Household Sample)

piecies

☐☐☐☐☐

5-9

11. How many posts did you or a member of your household cut in Michigan in the last 12 months? One cord = 100 pieces

(nearest percent)

Total = 100%

12. What percent of the posts cut were from:

☐ Trees inside city or village limits? ☐☐ % 10-11

☐ Fence rows, windbreaks, or yards of homes outside city or village limits? ☐☐ % 12-13

☐ Scattered trees on pasture or cropland? ☐☐ % 14-15

☐ Woodland areas outside city or village limits, but not including the yards of homes? ☐☐ % 16-17

☐ Other (specify)?_____ ☐☐☐ % 18-20

If woodland areas are a source, go to Question 13, if not go to Question 15.

(nearest percent)

Total = 100%

13. What percent of the posts cut from woodland areas were from:

Standing live trees? ☐☐ % 21-22

Logging waste or wood left over from logging? ☐☐ % 23-24

Dead trees, standing or down? ☐☐ % 25-26

Other (specify)? _____ ☐☐☐ % 27-29

If standing live trees were a source, go to Question 14, if not go to Question 15.

14. In the woodland areas, after the standing live trees were harvested, were the posts cut from the trees'

1☐ Trunks? 2☐ Limbs? 3☐ Both?

☐ 30

15. What species of timber did you cut for posts in the last 12 months? What percent of the total came from each of these species?

(nearest percent)
Total = 100%

☐	Cedar	☐☐ % (31-32)
☐	Red pine	☐☐ % (33-34)
☐	Oak	☐☐ % (35-36)
☐	Aspen	☐☐ % (37-38)
☐	Maple	☐☐ % (39-40)
☐	Ash	☐☐ % (39-40)
☐	Other (specify):	
	_____	☐☐☐☐ % (43-46)
	_____	☐☐☐☐ % (47-50)
	_____	☐☐☐☐ % (51-54)

16. In what counties did you cut posts during the last 12 months? What percent came from each county?

(nearest percent)
Total = 100%

_____	☐☐☐☐☐ (55-59)
_____	☐☐☐☐☐ (60-64)
_____	☐☐☐☐☐ (65-69)

17. During the last 12 months, what percent of the posts you cut came from:

(nearest percent)
Total = 100%

Land owned by a company that produces lumber, pulp, veneer, or other forest products? ☐☐ % 70-71

Your own property or other private land? ☐☐ % 72-73

National Forest land? ☐☐ % 74-75

Other Federal land? (Specify Federal Agency) ☐☐☐ % 76-78

_____

State land? ☐☐ % 79-80

County and municipal land? ☐☐ % 81-82

U.S. Department of Agriculture
Forest Service
North Central Forest Experiment Station

FELLED TREE MEASUREMENT FORM
Fifth Michigan Forest Inventory

FE	OE

Tree number (1–4) | State (5–6) = 2 6 | Unit (7) | County (8–9)

Products taken:
- Saw log
- Veneer
- Pulpwood
- Piling
- Poles
- Fuelwood
- Posts
- Other

Field party: _____

Date: _____

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Ownership	FIA species code			Leave blank	Stump diameter (outside bark)			Stump height		Site index (logging operation)		Site index species			Limbwood used for fuelwood (percent)			Limbs and tops missing (percent)			Leave blank			Butt log grade	D.B.H.			D.B.T. at D.B.H.		Tree grade	Growing-stock height		Diameter at growing-stock height (o.b.)			D.B.T. at growing-stock height		Saw log height		Diameter at saw log height (o.b.)			D.B.T. at saw log height	

55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	NOTES
Tree section		Tree class		Major product		Product		Dimension class		Cull deductions: Board feet			Cull deductions: Cubic feet			Dimensions: Length			Dimensions: Diameter (o.b.): Large end			Dimensions: Diameter (o.b.): Small end			Log grade	

Logging damage:

State (1–2) = 2 7 | Unit (3) | County (4–5)

6	7	8	9	10	11	12	13	14	15	16
Tree class	FIA species			Species (office)	D.B.H.		Number of trees		Major product	

Remarks:

NC-4800-3 (Revised December 1980)

APPENDIX C

Table C-1.--Primary product conversion factors

Product	Unit of measure	Multiplier to: Convert unit of measure to Std. cord 1/	Multiplier to: Convert unit of measure to MBF Intnl. 2/	Cubic feet per unit of measure	Multiplier to: Convert Std. cord to units of measure	Multiplier to: Convert MBF Intnl. to units of measure	Avg length per unit of measure
Saw logs and bolts	*Doyle MBF*	2.76	1.38	218.04	0.36	0.72	
Saw logs and bolts	*Scribner MBF*	2.16	1.08	170.64	0.46	0.93	
Saw logs and bolts	*International MBF*	2.00	1.00	158.00	0.50	1.00	
Veneer logs and bolts	*Doyle MBF*	2.28	1.14	180.12	0.44	0.88	
Veneer logs and bolts	*Scribner MBF*	2.08	1.04	164.32	0.48	0.96	
Veneer logs and bolts	*International MBF*	2.00	1.00	158.00	0.50	1.00	
Box bolts	*Standard cord*	1.00	0.50	79.00	1.00	2.00	
Pulpwood	*100" cord 3/*	1.04	0.52	82.16	0.96	1.92	100"
Pulpwood	*Standard cord*	1.00	0.50	79.00	1.00	2.00	96"
Mine tie, sawn	*Piece*	0.03	0.01	2.00	39.50	100.00	5.25'
Mine timber	*Piece*	0.08	0.04	6.67	11.85	25.00	10.9'
Mine timbers	*Standard cord*	1.00	0.20	79.00	1.00	5.00	
Mine timbers, hardwood	*Scribner MBF*	2.30	1.15	181.70	0.48	0.87	
Mine timbers, softwood	*Scribner MBF*	2.34	1.17	184.86	0.50	0.85	
Piling	*Piece*	.25	.100	19.75	4	10.00	25.0'
Pole	*Piece*	.10	.060	7.90	10	16.67	35.0'
Post, fence	*Piece*	.01	.005	0.79	100	200.00	8.0'
Tie, standard	*Piece*	.07	.035	5.50	14	28.57	8.6'
Tie, small	*Piece*	.05	.025	4.03	20	40.00	
Fuelwood	*Standard cord*	1.00	.400	70.00	1.00	2.50	
Heading stock	*Standard cord*	1.00	.400	79.00	1.00	2.50	
Match stock	*Standard cord*	1.00	.450	79.00	1.00	2.22	
Lath	*Thousand pieces*	.57		45.14	1.75		
Lath, bundle	*50 pieces*	.02		1.58	35		
Pallet	*Unit*	.03	.013	2.63	30	13.0	
Misc. products	*Standard cord*	1.00	.250	79.00	1.00	250.0	

1/ 128 cubic feet including wood, bark, and air space.

2/ MBF = Thousand board feet

3/ Sometimes referred to as a "Lake States cord".

Table C-2.–Factors to convert weight scaled wood with bark to cords

Species group	Average green weight of wood and bark per cubic foot of wood	Weight of standard cords (lbs/cord) 1/	Number of standard cords per ton	Weight of 100" cords (lbs/cord)	Number of 100" cords per ton
Jack pine	54	4,266	0.4688	4,428	0.4517
Red pine	54	4,266	0.4688	4,428	0.4517
White pine	53	4,187	0.4777	4,346	0.4602
Ponderosa pine	51	4,029	0.4964	4,182	0.4782
Southern pine	64	5,056	0.3956	5,248	0.3811
Other pines	52	4,108	0.4869	4,264	0.4690
White spruce	50	3,950	0.5063	4,100	0.4878
Black spruce	51	4,029	0.4964	4,182	0.4782
Balsam fir	54	4,266	0.4688	4,428	0.4517
Hemlock	61	4,819	0.4150	5,002	0.3998
Tamarack	59	4,661	0.4291	4,838	0.4134
Baldcypress	64	5,056	0.3956	5,248	0.3811
Eastern redcedar	48	3,792	0.5274	3,936	0.5081
Northern white-cedar	40	3,160	0.6329	3,280	0.6098
Other softwoods	49	3,871	0.5167	4,018	0.4978
White oak	68	5,372	0.3723	5,576	0.3587
Red oak	73	5,767	0.3468	5,986	0.3341
True hickory	71	5,609	0.3566	5,822	0.3435
Pecan hickory	66	5,214	0.3836	5,412	0.3695
Basswood	49	3,871	0.5167	4,018	0.4978
Beech	64	5,056	0.3956	5,248	0.3811
Yellow birch	68	5,372	0.3723	5,576	0.3587
Hard maple	70	5,530	0.3617	5,740	0.3484
Soft maple	62	4,898	0.4083	5,084	0.3934
Elm	63	4,977	0.4018	5,166	0.3871
Black ash	57	4,503	0.4441	4,674	0.4279
White and green ash	60	4,740	0.4219	4,920	0.4065
Sycamore	62	4,898	0.4083	5,084	0.3934
Cottonwood	59	4,661	0.4291	4,838	0.4134
Willow	56	4,424	0.4521	4,592	0.4355
Hackberry	60	4,740	0.4219	4,920	0.4065
Aspen	59	4,661	0.4291	4,838	0.4134
Paper birch	63	4,977	0.4018	5,166	0.3871
Sweetgum	69	5,451	0.3669	5,658	0.3535
Black tupelo	67	5,293	0.3779	5,494	0.3640
Black cherry	54	4,266	0.4688	4,428	0.4517
Black walnut	62	4,898	0.4083	5,084	0.3934
Butternut	52	4,108	0.4869	4,264	0.4690
Yellow-poplar	60	4,740	0.4219	4,920	0.4065
Other hardwoods	53	4,187	0.4777	4,346	0.4602
Noncommercial species	58	4,582	0.4365	4,756	0.4205

1/ 128 cubic feet consisting of 79 cubic feet of wood and 49 cubic feet of bark and air space.

Table C-3.– Factors to convert volume and weight of peeled pulpwood to standard cords 1/

Region and species group	Number of standard cords per 96-inch peeled cord	per 100-inch peeled cord	per green ton of peeled wood
Lake States			
Jack pine	1.2110	1.2615	0.4688
Red pine	1.2020	1.2521	0.4688
White pine	1.2060	1.2562	0.4777
Spruce	1.1330	1.1802	0.5014
Balsam fir	1.1650	1.2135	0.4688
Hemlock	1.2580	1.3104	0.4150
Tamarack	1.1430	1.1906	0.4291
Cedar	1.1300	1.1771	0.6329
White oak	1.1230	1.2812	0.3723
Red oak	1.1865	1.2359	0.3444
Hickory	1.1430	1.1906	0.3701
Basswood	1.1940	1.2438	0.5167
Beech	1.0700	1.1146	0.3956
Yellow birch	1.1410	1.1885	0.3723
Hard maple	1.1370	1.1844	0.3617
Soft maple	1.1430	1.1906	0.4083
Elm	1.1750	1.2240	0.4018
Ash	1.1920	1.2417	0.4330
Cottonwood	1.1910	1.2406	0.4291
Balsam poplar	1.1980	1.2479	0.4083
Aspen	1.2070	1.2573	0.4291
White birch	1.1620	1.2104	0.4018
Other species	1.1060	1.1521	0.4688
Central and Plains States)			
Softwoods	1.2020	1.2521	0.4688
Soft hardwoods	1.1636	1.2120	0.4171
Hard hardwoods	1.1831	1.2324	0.3708
Residues (All regions)			
Softwoods			0.4878
Hardwoods			0.4545
All residue, dry			0.8000

1/ 128 cubic feet including wood, bark, and air space.

Table C-4.–Specific gravity, green and dry weight, and moisture content for wood and bark by species group

Species group	Wood			Bark				Average moisture content 4/
	Specific gravity 1/	Green weight	Oven dry weight 2/	Specific gravity 1/	Green weight	Oven dry weight	Bark content 3/	
		(lbs/cu.ft.)	*(lbs/cu.ft.)*		*(lbs/cu.ft.)*	*(lbs/cu.ft.)*	*(percent)*	*(percent)*
Jack pine	0.40	47	25	0.34	21	17	90	90
Red pine	0.41	49	26	0.24	29	15	16	90
White pine	0.37	43	23	0.49	59	31	16	90
Ponderosa pine	0.38	45	24	0.34	40	21	15	90
Southern pine	0.47	58	29	0.32	40	20	15	100
Other pines	0.40	45	25	0.4	45	25	15	80
White spruce	0.37	46	23	0.29	36	18	10	100
Black spruce	0.38	45	24	0.38	46	24	14	90
Balsam fir	0.34	46	21	0.38	53	24	15	120
Hemlock	0.38	50	24	0.4	53	25	21	110
Tamarack	0.49	55	31	0.3	34	19	13	80
Baldcypress	0.42	57	26	0.4	55	25	13	120
Eastern redcedar	0.44	43	27	0.4	40	25	12	60
Northern white-cedar	0.29	36	18	0.3	38	19	12	100
Other softwoods	0.38	43	24	0.45	50	28	13	80
White oak	0.60	59	37	0.53	53	33	18	60
Red oak	0.56	63	35	0.65	74	41	14	80
True hickory	0.64	64	40	0.6	59	37	13	60
Pecan hickory	0.60	59	37	0.6	59	37	13	60
Basswood	0.32	40	20	0.45	56	28	16	100
Beech	0.56	59	35	0.56	60	35	7	70
Yellow birch	0.55	61	34	0.56	63	35	12	80
Hard maple	0.56	63	35	0.54	61	34	12	80
Soft maple	0.49	55	31	0.52	58	32	12	80
Elm	0.46	58	29	0.28	34	17	14	100
Black ash	0.45	50	28	0.45	50	28	14	80
White and green ash	0.54	54	34	0.34	34	21	16	60
Sycamore	0.46	58	29	0.45	56	28	8	100
Cottonwood	0.37	50	23	0.43	59	27	15	120
Willow	0.34	46	21	0.43	59	27	16	120
Hackberry	0.49	52	31	0.49	53	31	15	70
Balsam poplar	0.37	50	23	0.5	68	31	18	120
Aspen	0.39	48	24	0.5	62	31	18	100
Paper birch	0.48	54	30	0.51	58	32	16	80
Sweetgum	0.46	60	29	0.46	61	29	15	110
Black tupelo	0.46	58	29	0.46	58	29	15	100
Black cherry	0.47	49	29	0.48	51	30	10	70
Black walnut	0.51	57	32	0.28	31	17	15	80
Butternut	0.36	44	22	0.4	50	25	15	100
Yellow-poplar	0.40	52	25	0.4	53	25	15	110
Other hardwoods	0.42	46	26	0.42	47	26	15	80
Noncommercial species	0.45	50	28	0.45	50	28	15	80

1/ Based on weight oven-dry and volume when green.

2/ Computed from specific gravity presented (based on green volume).

3/ Expressed as percent of green wood volume. To express as a percent of total green volume including bark, multiply the percent shown by (1.0/(1.0 + decimal value of percent shown)).

4/ Expressed as percent of oven-dry weight. To express as a percent of green weight, divide the green weight minus dry weight by the green weight.

Table C-5.--Factors to estimate wood residues generated per standard unit of mill production by product, species group, and type of residue 1/

Type of roundwood product	Species	Type of residue	Type of mill	Unit of measure	Multiplier to: determine volume of residue per unit of product measured		
					Cubic feet	*Green tons*	*Oven-dry tons*
Saw logs	All	Coarse	All	MBF 2/	48	1.34	0.789
	All	Fine	Band	MBF	16	0.45	0.265
	All	Fine	Circular	MBF	28	0.78	0.459
	Group 1 *3/*	Bark	All	MBF	18	0.34	0.212
	Group 2 *4/*	Bark	All	MBF	31	0.57	0.366
Veneer logs	All	Coarse	All	MBF	28	0.78	0.459
	All	Fine	All	MBF	45	1.25	0.736
	All	Bark	All	MBF	31	0.57	0.366
Cooperage logs	All	Coarse	All	MBF	33	0.92	0.542
	All	Fine	All	MBF	54	1.51	0.889
	All	Bark	All	MBF	31	0.57	0.366
Handle bolts	All	Coarse	All	MBF	48	1.34	0.789
	All	Fine	All	MBF	16	0.45	0.265
	All	Bark	All	MBF	31	0.57	0.366
Cabin logs	Group 1 *3/*	Bark	All	MBF	18	0.34	0.212
	Group 2 *4/*	Bark	All	MBF	31	0.57	0.366
Posts	All	Bark	All	Thou. pieces	90	1.70	1.063
Poles	All	Bark	All	Piece	1.67	0.03	0.020
Misc. products	Group 1 *3/*	Bark	All	MCF	114.00	2.15	1.346
	Group 2 *4/*	Bark	All	MCF	196.20	3.61	2.316

1/ Factors for products using board foot measure are based on data presented in the paper "Conversion factors for estimating green tons of sawmill residue from log consumption" by Bruce A. Haataja and Leland W. Hooker, Institute of Wood Research, Michigan Technological University, November 1965. Other factors presented are synthesized from various studies conducted in the eastern U.S. and selected mill analysis.

2/ International 1/4-inch rule.

3/ Group 1 = Thin barked species - balsam fir, spruce, tamarack, cedar, sycamore, and beech.

4/ Group 2 = all species not in Group 1.

Table C-6.–Factors to convert common units of fuelwood measurement to standard cords

	Std. cord equivalent
Vehicles	
3/4-ton pickup	.4600
1/2-ton pickup	.3850
Small pickup *(Nissan, Toyota, Ranger, S-10, etc)*	.2400
Full size car trunk	.1667
Small size car trunk	.1000
Subruban (Carryall)	.5000
Full size van	.5000
Small size van	.4000
Full size station wagon	.2500
Small station wago	.1667
Small hatchback	.1250
Bundles or pieces	
Small bundle	.0300
50 piecies	.1667
100 piecies	.3333
150 piecies	.5000
200 piecies	.6667
300 piecies	1.0000

	Std. cord equivalent
Weight	
Pound: green wood	.0002
Pound: dry wood	.0003
Ton: green wood	.4167
Ton: dry wood	.6667
Volume	
Cubic feet	.0143
Face cord: 4'x8'x12"	.2500
Face cord: 4'x8'x16"	.3333
Face cord: 4'x8'x18"	.3750
Face cord: 4'x8'x24"	.5000
Full cord: 4'x8'x4' (std. cord)	1.0000
Trees (bolewood only)	
5-inch tree	.0330
10-inch tree	.1660
15-inch tree	.4000
20-inch tree	.8000
25-inch tree	1.2500
30-inch tree	1.8500
40-inch tree	2.6500

Estimated average standard cord equivalents for fuelwood produced from tops and limbs of trees of various diameters

Tree dbh	Pines and tamarack	Other softwoods	Aspen	Other hardwoods
5	.005	.013	.012	.015
10	.019	.047	.042	.056
15	.042	.092	.084	.112
20	.080	.160	.151	.195
25	.122	.226	.218	.274
30	.177	.310	.305	.373
40	.250	.395	.404	.466

Table C-7.–Multipliers to convert Doyle and Scribner rule to International 1/4-inch rule for hardwoods and softwoods*

DBH	Convert to Doyle		Convert to Scribner	
(inches)	Softwoods	Hardwoods	Softwoods	Hardwoods
9.0-10.9	.3455	--	.7830	--
11.0-12.9	.4780	.4172	.8287	.8317
13.0-14.9	.5992	.5118	.8577	.8611
15.0-16.9	.6908	.5882	.8784	.8827
17.0-18.9	.7685	.6569	.8945	.8999
19.0-20.9	.8573	.7180	.9079	.9132
21.0-22.9	.8645	.7829	.9168	.9239
23.0-24.9	.9276	.8324	.9240	.9325
25.0-26.9	.9493	.8736	.9299	.9396
27.0-28.9	.9710	.9473	.9321	.9454
29.0+	1.1065	1.1349	.9357	.9544

** Result of multiplication will be volume in Doyle or Scribner board feet.*

Table C-8.–Multipliers to convert from Doyle and Scribner rule to International 1/4-inch rule for hardwoods and softwoods*

DBH	Convert from Doyle		Convert from Scribner	
(inches)	Softwoods	Hardwoods	Softwoods	Hardwoods
9.0-10.9	2.8944	--	1.2771	--
11.0-12.9	2.0921	2.3969	1.2067	1.2024
13.0-14.9	1.6689	1.9539	1.1659	1.1613
15.0-16.9	1.4476	1.7001	1.1384	1.1329
17.0-18.9	1.3012	1.5223	1.1179	1.1112
19.0-20.9	1.1665	1.3928	1.1015	1.0951
21.0-22.9	1.1567	1.2773	1.0907	1.0823
23.0-24.9	1.0781	1.2013	1.0823	1.0723
25.0-26.9	1.0534	1.1447	1.0753	1.0643
27.0-28.9	1.0299	1.0556	1.0728	1.0578
29.0+	.9038	.8811	1.0687	1.0478

** Result of multiplication will be volume in International board feet.*

Table C-9.– Common metric equivalents of units used in forestry

1 acre =	*4,046.86 square meters or 0.405 hectare.*
1,000 acres =	*405 hectares.*
1 cubic foot =	*1 cubic foot = 0.0283 cubic meter.*
1 foot =	*30.48 centimeters or 0.3048 meter.*
1 inch =	*25.4 millimeters, 2.54 centimeters, or 0.0254 meter.*
1 pound =	*0.454 kilograms.*
1 ton =	*0.907 metric tons.*

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Smith, W. Brad.
1991. **Assessing removals for North Central forest inventories.** Res. Pap. NC-299. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 48 p.

Discusses methods used by the Forest Inventory and Analysis Unit for estimating timber removals. Presents the relationship of timber utilization studies, primary timber mill studies, and forest inventory data.

KEY WORDS: Utilization, products, wood-using mills, growing stock.

Our job at the North Central Forest Experiment Station is discovering and creating new knowledge and technology in the field of natural resources and conveying this information to the people who can use it. As a new generation of forests emerges in our region, managers are confronted with two unique challenges: (1) Dealing with the great diversity in composition, quality, and ownership of the forests, and (2) Reconciling the conflicting demands of the people who use them. Helping the forest manager meet these challenges while protecting the environment is what research at North Central is all about.